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CORPORATION COMMITTEES AND DEPUTATIONS.

IN connection with the adoption of mechanical power on tramways, the history of electric lighting development is in at least one respect being repeated. In the earlier days of municipal electric lighting, committees were appointed to visit various parts of the country, at the expense of the ratepayers, to inspect the lighting systems then in operation, in order to obtain information which would guide them in coming to right conclusions. This was carried to such an extent, that protest after protest had to be made. The craze, however, has by no means died out in connection with electric lighting, for only a week or two ago we recorded an instance where extensions to the lighting system became necessary, and a deputation was sent to see how they carried out such extensions elsewhere. But there is an even greater danger of this eagerness on the part of Committeemen for trips to other towns being carried too far in respect to the adoption of mechanical traction.

There are several good instances of the electric trolley system in operation in this country, which would furnish any deputation with ample information to help them to decide the matter in their own minds without going further afield. But it is becoming the fashion to send costly commissions to a dozen or so Continental cities, in addition to English and Irish towns, and it seems that the time has come for a strong protest to be made against such municipal extravagance. No one having the interests of electric tramway working at heart would hinder the Town Councillor securing in as easy and thorough a manner as possible all the information necessary for his purpose, but it certainly seems that the investigations of such committees and deputations as were sent from Glasgow, Sheffield, Belfast, and other places to foreign cities have led to the publication of such details and opinions as should enable any ordinary councillor to come to a decision on the subject without actually going to see the systems for himself. The very thorough and elaborate publications of the Glasgow Committee, and also those of the Committees from the other cities mentioned, contain technical, general, and illustrative detail which, supplemented by the advice of an expert electric traction man and a study of the technical journals, should be sufficient. It is true that the needs of Glasgow might not be identical with those of Birmingham, Sheffield, or other towns, but the information now at hand would be quite ample for guiding the Corporation generally as to the comparative merits of cable, steam, horse, and the various electrical systems.

In some cases these deputations are sent at the expense of the Municipality, although the tramway system is owned and operated by a company, merely for the purpose of seeing whether there is any objection to the promoters' proposals. In this connection we have particularly in mind the deputation which we believe is now away on the Continent from Birmingham. This is a rather expensive way of protecting the city's interests.

Another important point is, that although these little parties go exhaustively into the subject, and make their recommendations, the wisdom of their suggestions is questioned by those who originally sent them. The position of Glasgow is an instance of this. The latest information to hand says that the Tramways Committee will hold a special meeting on April 1st to go "into the whole question of motor power for the cars" of the city. What with costly deputations, elaborate reports, a score of special and general meetings, and never-ending discussions, the Glasgow Committee and Corporation is in a fair way toward finding itself in an absurd dilemma on account of the profuseness of its information—much of which, by the way, it probably does not altogether appreciate. True, the question is a very important one for a city like Glasgow, possessing so extensive and profitable a tramway service, but the repeated delays are beginning to make the Corporation little short of a laughing stock, especially as the proposal is to equip, in the first place, only one short section, as an experimental line. It is not a proposal to equip all the city lines by the overhead trolley; if it were, the protracted delays might be more in keeping with the circumstances. The amount of money which has been spent upon deputations to other cities in England, Europe, and America would have gone a good way toward the equipment of a short line, from which the Corporation might have judged the suitability thereof for the entire city.

We cannot but think that rival interests have something to do with this dilly-dallying, and the sooner the matter is decided, the better it will be for the dignity of the Corporation.

BOILER INSPECTION.

We are glad to see that the *Engineer* has taken up the cudgels in opposition to the Bill for Boiler Inspection and Registration that is being promoted by the Manchester Steam Users' Association. This Bill makes boiler inspection compulsory, but lays down no standard of qualification for inspectors, so that anyone could undertake inspection. We are at one with our contemporary in condemning the harassing legislation which is being needlessly rushed upon steam boiler owners.

The inspection of steam boilers has, on the whole, been fairly carried out in this country by the voluntary associations. In no country are there fewer explosions than in England. In the United States, where the police are in some cities the inspectors of boilers, they go about with a van and a force pump, and having well strained a boiler by hydraulic pressure, they leave it safe to burst by steam pressure. The Manchester Steam Users Association has some officialism in its ordering which is in the opinion of the *Engineer* short of candour. This is marked by the inclusion as explosions of such trivialities as failure of manhole cover packing or splitting of fire tubes—accidents that no official inspection could possibly prevent. The truth is that the Manchester Steam Users' Association has been mad on legislation for some years, and up to now has effected no useful legislation. The first fruits of their efforts was to turn upon the stationary boiler interest a flock of marine inspectors who did not know the work, and wrote some very foolish reports. The spare funds of the Association, which are very large, might better be employed in reducing the excessive labour of their inspectors than in promoting Bills. If the Steam Users' Association had to live by competitive work, and had less power to pick up the good boilers and refuse poor ones, it would find that serious results would follow upon the excessive strain put upon inspectors. Is it not a fact that more good is likely to arise when a boiler insurance company takes all the boilers offered and tries to bring them into a better condition, than when a mere inspecting society simply picks its boilers, rejecting all inferior boilers and guaranteeing all the first raters? The truth is that the Steam Users' Association calls to repentance the good only, and leaves the sinners to perish without an effort. Yet it is this latter class which is in need of inspection.

The Theory of Lead Accumulators.

There was an extremely interesting paper a few months ago, by Maurice Barnett, in the *Electrical World* (N.Y.) (to which we referred in a recent issue), in which the author traced the history of the views which have been held concerning accumulators from the commencement, and doubtless many of our readers have read the article in question. The author, however, was unable to refer to some recently published papers by C. Liebenow, who has set himself the task of endeavouring to find more simple explanations of the reactions which go in the secondary cell, than are at present entertained. Of course the theory is based upon assumptions, as, unfortunately, all the other theories are based on the secondary cell also. The special assumption which Liebenow made, in endeavouring to describe the reactions more simply, was that negative PbO_2 ions are present. Hitherto, however, the existence of such ions has not been proved, but in the *Zeitschrift für Electro Chemie*, 1896, 2 (30), p. 653, Liebenow sets out seriously to prove that these ions actually have an existence under the conditions referred to. His method of argument is somewhat as follows:—Consider an aqueous solution of the compound $Pb(KO)_2$. If it is to be regarded as a solution of the double oxide PbO, K_2O, it ought to split up into ions in accordance with the equation—

$$Pb(OH)_2, 2KOH = \overset{++}{Pb} + \overset{+}{2K} + 4\overset{-}{OH}. \qquad (I)$$

but, if it is to be regarded as a solution of lead plumbate, it ought to split up into ions according to the equation—

$$K_2\,PbO_2\;\overset{+}{2K}\;\overset{--}{PbO_2}. \qquad (II)$$

which view is correct, as may be tested as follows:—A dilute solution of caustic potash is electrolysed between platinum electrodes (wires) in a glass cylinder divided by suitable membranes into three parts. The solution in the middle part is saturated with lead oxide, the parts on either side containing only potash. When a current is passed, oxygen is evolved at the anode, and hydrogen at the cathode. At the same time all positive ions in the electrolyte move towards the positive electrode. If the lead only gives rise to positive metallic ions (equation I.), it will move with the sodium ions in the direction of the current; but if it gives rise to the current PbO ions (equation II.), these will move in a direction opposite to that of the current. The author finds that the latter is what actually takes place, and regards this as conclusive proof of the existence of negative PbO_2 ions. It now remains for others to repeat these experiments, and to find confirmation of the results which Liebenow obtained from them, if that be possible, whether the proof of the actual existence of negative PbO ions be verified or not, a step will certainly have been taken in the right direction. In the evolution of a theory it is often quite as important to refute as to confirm any given statement likely to have an important bearing upon it.

NOTES ON RÖNTGEN RAY WORK.

In a paper read by Willyoung and Sayen before the Franklin Institute it was stated that a 30 minutes exposure was necessary to obtain a good Röntgen photograph of the human trunk, the tube being at a distance of 12 to 15 inches. The readers of the paper stated that after the most careful inquiries they had not been able to hear of a good photograph of the trunk being produced in less time than this. A correspondent of the *Electrical Review*, N.Y. (Dr. Monell), however, writes to say that with a tube in good working condition he has obtained first-class photographs of the trunk in 5 minutes, the tube being 13 inches in front of the person's chest. A tube of the highest efficiency is necessary to produce this result.

The following are some of the exposures recommended by Messrs. Willyoung and Sayen: Hand and wrist, 5 to 10 seconds at 5 inches; forearm, 10 to 15 seconds at 5 inches; arm above the elbow, ½ to 1 minute at 7 inches; shoulder, 10 to 15 minutes at 10 inches; thorax, 15 to 30 minutes at 10 inches; hip joint, 30 to 45 minutes at 12 to 15 inches; stones in kidneys, 30 to 45 minutes at 12 to 15 inches; glass, iron, lead, &c., in any part of trunk, 30 minutes on an average, at 12 to 15 inches.

M. De Fonvielle states that the urate of lime, which when deposited in the hands and feet, gives rise to gout, is eight times less opaque to the Röntgen rays than the phosphate of lime which forms the principal ingredient of bones. It is thus easy to distinguish between the two on the Röntgen photograph.

The inflammatory action on the skin caused by long exposure to the Röntgen rays has frequently been recorded. It has been compared to severe sunburning, but the scientists appear to differ considerably as to the explanation of this peculiar effect. Prof. Stine records in the *Western Electrician* a similar effect which was produced on the exposed skin of one of the operators by a powerful electric arc which was being used to pierce a cast-iron plate. The exposure to this light did not last 3 minutes, but within 24 hours afterwards the face grew red and inflamed, the effect being similar to that produced by long exposure to the Röntgen rays. Mr. T. E. Gatehouse, as long ago as 1878, while experimenting with an arc lamp invented by Sabine, having one of the electrodes of cast-iron, experienced a similar blistering effect. Stine considers that the presence of iron in the arc increases the percentage of ultra-violet rays, and to these he attributes the sunburning effect. Any explanation, however, in our present state of ignorance about the Röntgen rays, must be more than doubtful.

Messrs. Willyoung and Sayen, in the paper referred to above, state as the result of their experience that the simple induction coil is much superior to the Tesla coil for exciting the X-ray tube. Among the points in favour of the induction coil enumerated are the following: there is one coil instead of two, and the apparatus is consequently easier to manipulate; the oil bath of the Tesla coil is not cleanly, and is liable to thicken and to destroy the insulation; the definition obtained with Tesla currents is never so sharp as with the simple induction coil discharge; and the Tesla discharge makes more noise and is more destructive to the tubes.

In discussing the question of tubes they recommend highly the Bowdoin tube invented by Professors Robinson and Hutchins. This, as will be seen from the figure, is of the focus tube type, but differing somewhat in form from the tube we are familiar with in this country. The anode is a disc placed behind the anticathode, and the glass is blown out into a thin bulb opposite the anticathode. The special feature, however, about this tube is that the inside of the tube is lined with a phosphorescent material fused into the glass. This, in some mysterious way, appears to prolong the action of the tube, by preventing the vacuum running up to an unworkable limit.

Besides the ordinary methods of regulating the vacuum in the tube, the authors mention the fact that it has been the practice of some makers to blow a pocket in the side of the tube to contain a small quantity of phosphoric anhydride. On heating this substance it gives off sufficient vapour to reduce the vacuum to the right amount. Messrs. Willyoung and Sayen consider that this kind of regulation is not sufficiently delicate and is liable to overshoot the mark. Their experience, however, appears to contradict that of Prof. Dorn,* who has used caustic potash in this way with complete success.

Many attempts have been made to use the influence machine instead of the induction coil for exciting the X-ray tube. Mr. Porter appears to have obtained very good results by introducing several spark gaps and induction spirals into the circuit between the electrodes of the machine. In one of his experiments a Wimshurst machine with two 15-inch plates was used to excite the tube. Several different arrangements are described by Porter,† one of the best of which may be described as follows: Starting from the negative electrode of the machine we have first a ½-inch air gap, then a spiral conductor, then a ¼-inch air gap, then the cathode of the tube, then between the anode of the tube and a second spiral conductor a ½-inch air gap, and finally between the spiral and the positive electrode of the machine a very small air gap. This arrangement gives a series of

very brilliant flashes in the tube; the human backbone can be seen on the screen through 8½ inches of brick. The images given on the screen with this arrangement are very brilliant and steady. The behaviour of the tube appears to be somewhat eccentric when excited by the influence machine. After a time, patches and streaks appear on the sides of the tube which stopped the Röntgen ray discharge. The spots are more numerous near the cathode, forming near it and gradually elongating towards the anode. Blowing on the middle of the tube causes them to retreat to the cathode; but blowing on the cathode end of the tube causes them to move towards the anode. Porter's theory is that the positive charge on the tube draws the air particles away from the centre and produces there a higher vacuum. This theory is apparently confirmed by Dr. Berliner's method of regulating the vacuum in tubes, described recently in the Electrical Review.

FAULTS IN ARC LAMPS AND HOW TO FIND THEM.‡

Arc lamps are built so differently that a review of the possible faults of every type would constitute a book in itself, and consequently attention in this article will be confined to the faults that are common to the various classes. Special mechanical troubles must in a great measure be excluded, and the available space be devoted to the electrical ones.

There are three commercial circuits on which arc lamps are burned, namely, the constant current where the lamps burn in series, and the constant potential, both alternating and direct, in which the lamps burn in multiple or multiple series. There is further the 500-volt railway current in which the multiple series system is used.

The series arc lamp system, which was the earliest in use, employs lamps which may be divided into classes according to their mechanism and the way in which it operates. There are two great classes, the open and the closed circuit lamps. The distinguishing feature in these is, that in the open circuit lamp the carbons are apart on starting, and fall together and then separate upon drawing the arc. With the closed circuit lamps the carbons are together on starting, and when the current flows the carbons simply separate and the arc follows. The electrical mechanisms are of two kinds:—First, the differential mechanism; and second, the shunt mechanism, which latter has only lately appeared on the market. Both of these mechanisms employ a coil of coarse wire and another of fine wire. The coarse wire coil is in series with the main circuit, and is known as the series coil, while the finer coil has its terminals connected to the terminals of the lamp, and is therefore in multiple with it.

* *Elektrotech. Zischr.* 17, p. 706, 1896.
† *Nature*, Vol. 55, p. 30.
‡ *American Electrician.*

It is easy to see that the series coil will only operate its mechanism when the current varies in strength, while the shunt coil will move its mechanism when the arc becomes too long or too short, or when the potential at the terminals of the lamp varies. Therefore, in any series arc lamp the shunt coil is the one that does the regulating and feeding, because the current is automatically kept constant by the dynamo that feeds the system, and therefore, when the current is once on, the strength of the series coil does not vary.

The series coil is used to start the lamp, and its action is as follows:—The current being turned into the lamp the series coil is energised, and moves the carbons apart if the lamp is a closed circuit one, and its influence on the mechanism of the lamp remains the same as long as the lamp is burning. As soon as the carbons are burned apart to any considerable extent, the shunt coil becomes so powerful as to overcome the influence of the series coil, and moves the carbons nearer together. Presently the carbons are still more consumed, and the shunt armature is attracted so powerfully that the mechanism is released and the lamp feeds.

With the open circuit lamp, on the other hand, the series coil is not in circuit until after the lamp is started. The shunt coil drops the carbons together, a strong current flows,

Fig. 1.—Diagram of Differential Arc Lamp.

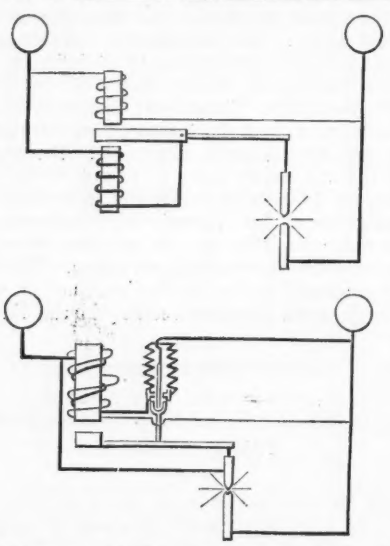


Fig. 2.—Diagram of Shunt Arc Lamp for Series Circuit.

and the series coil pulls them apart again, thus drawing the arc, after which feeding and regulation is accomplished in precisely the same way as in the closed circuit lamp.

The diagram of fig. 1 shows the principle of the differential series arc lamp, and by consulting it the foregoing may be more easily understood.

The shunt lamp for series system has a series coil, it is true, but this coil is cut out after the lamp has been started, the separation of the carbons being accomplished by weights or springs. This lamp has the advantageous feature that variation of the strength of current does not materially affect it. Fig. 2 is a diagrammatic representation of this system. All of these lamps are provided with a cut-out which short circuits the lamp in case an accident occurs to the mechanism.

Arc lamps may be further divided into clutch and rack-feed lamps. The former employ a friction clutch which acts on the feeding mechanism, and the latter use a rack and pinion to work the carbons and control the spindle on which the spindle is mounted. Clutch lamps will be considered first.

These facts being understood, some of the faults that are likely to occur may be discussed. Like the faults in any electrical device, they are due to short circuits, open circuits or grounds in some part of the electrical system. If one of the electrical circuits rings on to the frame of the lamp when tested with a magneto, that does not necessarily indicate a fault, for some lamp frames are intentionally grounded. Supposing the inoperative lamp to be one of the closed circuit type, shut off the current and see if the ends of the carbon are together and will lift apart freely. It sometimes happens that the ends of the carbons do not nose properly, and fall past each other, wedging the mechanism so that it becomes inoperative.

If a lamp appears externally all right, it may start with a shake or a jar, and although this may answer for a time, the lamp should be immediately noted as one that needs repair. If this examination is made in the repair shop, of course the case should be opened and examined. Look first to the automatic cut-out and see if that is open. If such is the case, the series coil, the shunt coil, or the lamp itself may be short-circuited. If the shunt coil or the lamp is short-circuited, the latter will not operate till the short circuit is removed, for such a fault has precisely the same effect as throwing the cut-out switch. If the carbons are lifted apart, no arc will follow, and as soon as they are released they will fall together again.

In some few lamps the shunt coils are connected across the carbons. In such a case the series coil would hold the carbons wide open, and would open them if they were forced together, but there would be no arc, because the gap between the carbons is short-circuited. If the short circuit between the shunt coils were only partial, and a few amperes only were diverted from the arc, the latter might operate, but the shunt bobbin would get very hot, and would ultimately burn out.

If it be the series coil that is short-circuited, the lamp will not start, but if the carbons are separated by hand an arc will follow. What happens next depends upon the form of the mechanism. If the lamp is, electrically, a differential one, that is, the shunt and series bobbin act on the same core and neutralise each other's effect, the shunt bobbin will attract the armature in just the same way that the series bobbin would, and will hold the carbons open the more firmly as the arc burns longer and longer, unless the cut-out is arranged to operate and prevent this. If, on the other hand, the lamp is mechanically differential—that is, both bobbins pull in oposite directions on the same armature—the increasing strength of the shunt bobbin will suddenly cause the carbons to run together, and the arc will cease, for there is no operative series coil to re-establish it.

If the lamp be of the open circuit type, the symptoms of short-circuited shunt and series bobbins are different. If the shunt bobbin is short-circuited, the carbon will remain apart, no matter how the series coil is connected, but if it be connected across the carbons simply, it will be notably harder to press the latter together, for the series coils assist the weights or springs. If the series coil is short-circuited, the lamp will chatter and flash. The shunt coil will permit the carbons to run together, and as soon as they touch, the shunt coil loses its energy, and the weights or springs will separate the carbons. The shunt coil will act again, and the carbons will be brought together, and so the chattering will proceed in much the same way as does the vibrator on an electric bell. If the weights or springs be made strong enough, the lamp may operate; but if the shunt bobbin has been constructed to operate against the combined influence of the weights or springs and the series coil, the loss of the force of the latter by short-circuiting will allow the shunt coil to have everything its own way.

Turning to open circuits as a source of trouble, it may be said of all series arc lamps that to open circuit in the main circuit, which includes the series coil, is impossible. If the circuit of a large modern arc machine were opened by special means, an arc from 2 to 5 feet long would follow, and it is obvious that if a break should occur within the limited confines of the box containing the lamp mechanism, an arc would be formed of sufficient stability to allow the current to flow, and the lamp mechanism would suffer. This would not occur, however, for all modern arc lamps have a cut-out device which prevents such accidents.

Open circuits in the shunt coil, however, disable it, and the carbons will burn apart till the cut-out acts. If the lamp is of the open circuit type, it will not start unless some outside influence is brought to bear, and once started, it will behave precisely as the closed circuit lamp.

The shunt arc lamp for series circuit is a special production of the Adams-Bagnall Company, of Cleveland, O., and

its radical difference from other mechanisms in electrical details makes it worthy of mention. When this lamp is quiescent and no current flows, the series coil is cut across the terminals. The flow of current actuates this coil and it pulls its armature, the motion of which brings the carbons together and cuts out the series coil, which instantly drops its armature. The carbons come apart, drawing an arc after them, and the shunt coil thus brought in play catches the armature as it falls, and regulates and feeds the carbons. Its action is balanced by an ingenious system of weights. If the series coil of such a lamp were short-circuited, it would refuse to operate, but if started by artificial means, it would continue to run, for in its running position the series coil is cut-out and a fault in its winding does not affect the lamps. The short-circuiting of the shunt coil would in this lamp be equivalent to short-circuiting the lamp itself, and it would refuse to operate.

Automatic cut-outs are now in general use on series arc lamps, and a little description of their principles and action is essential to the investigation of faults. The office of such cut-outs is to short-circuit the lamp when the circuit within the lamp is broken either by the falling out of a carbon, the failure of a wire, or other cause. When such an open circuit occurs, the potential at the lamp terminals raises enormously. Therefore, as would naturally be supposed, the cut-out, if it be electro-magnectic, is actuated by a coil, either in series with the shunt bobbin, or itself shunted across the lamp terminals.

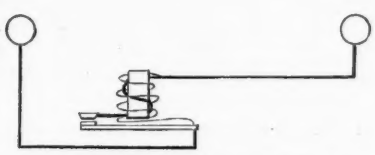


Fig. 3.—Diagram of Automatic Cut-out.

Since when the lamp is thus short-circuited, the potential difference at the lamp terminals is practically zero, the shunt cut-out bobbin would fail in its function, as in cutting out the lamp it also cuts out itself. This is provided for by the introduction of a series coil at the instant that the shunt coil is cut out. The arrangement is diagrammatically shown in fig. 3. If the series coil becomes disabled on such a device by short-circuiting, the cut-out will flutter open and start pulling an intermittent arc at its contacts. If the shunt coil is disabled and inoperative, the cut-out will not act, and serious results may result if its action should be called for.

Some lamps use a mechanical cut-out to short-circuit the lamp after the carbons have been burned out. This is usually accomplished by allowing some projection on the feed-rod to descend upon and operate a mechanism.

The rack-feed lamp differs from the clutch lamp only in mechanical detail. Its electrical contact is substantially the same. The pinion which engages in the rack drives a train of wheels terminating in an escapement, precisely the same as in an ordinary clock. Instead of being controlled by a pendulum, the escapement is controlled by an electro-magnetic mechanism. As a usual thing, a rack feed is preferable to a clutch where both are in order, but the complication of the power renders them unsuitable for operation in exposed places.

The subject of faults in constant potential lamps will be taken up in another article.

PREVENTION OF ELECTRICAL FIRES.

If anyone is to be congratulated upon the paper which Mr. Bathurst read before the Society of Arts on Wednesday last, it is the fire insurance companies. The statistics relating to losses by fire from electrical causes, which the insurance companies undoubtedly possess, but which Mr. Bathurst has not been able to obtain from them, may, however, after all have more weight than some of the possibilities suggested in his paper. According to Mr. Bathurst, we, in this country, are in a very embryonic stage in respect to our methods of wiring for electric lighting, and the use of wood casing, which we suppose is the material adopted for carrying the wires in 95 per cent. of the installations in this country, he entirely condemns. He points out "that wood absorbs moisture; that it immediately becomes an inefficient insulator; that the overheating of a wire by excess of current will cause wood casing to take fire; that the voltage also determined the ability of the energy transmitted to break through any environment or insulation; and that time, heat, cold, chemical action and moisture, are all powerful influences which tend to deteriorate any insulating materials in use commercially."

Mr. Bathurst then goes on to deal with fuses as a protection against leakage. He says: "A fuse so small as 5-ampere capacity will not prevent a 4-ampere leak, whereas, with favourable (*sic*) conditions, a leakage current of 2 amperes can cause a fire." We think these extracts will show the drift of the argument, and we ourselves might, with an effort of imagination, add a few more dire possibilities of electrical risks to the almost exhaustive list contained in the paper.

With regard to the *probabilities*, however, of these thousand and one defects occurring, Mr. Bathurst says nothing, and up to this point in the paper we merely have a repetition of the possible dangers and drawbacks to electric lighting, which, we are told at the commencement of the paper, constituted the basis of the "danger scare" which was "created about the year 1880 upon the introduction of electric lighting." Mr. Bathurst has, evidently, come to the conclusion that sufficient time has elapsed since 1880 to admit of another scare on the same identical basis, but at the present conjuncture he is ready with a remedy, namely, his own system of conduits for electric wires. This system we have no reason to think to be otherwise than excellent and efficient, but the claims which the author advances for it over and above the use of wood casing are little less than absurd and untenable. In each case defects will arise if the work is badly executed, and, of course, the author says very little as to the many defects which are peculiar to the use of tubing of any kind, but which do not occur with wood casing. For instance, through the ordinary differences in temperature of the atmosphere, condensation will occur in a tube, filling the bends with moisture, which the author admits, but no insulating lining can be guaranteed to withstand fracture under all circumstances, and hence any defect in the cable at such a point would cause a more serious leakage in an iron pipe containing water than any leakage on wooden casing.

The tube, in fact, would form a conductor of electricity at a high potential to all parts of the building, giving rise to a general danger throughout, whereas if wood casing were the medium, the fault would be localised.

The author further desires to warn "these insurance companies still upholding the use of wood casing to be on their guard lest they should find themselves nurturing this practice under the *ægis* of tradition." Presumably, all Mr. Bathurst wants the insurance companies to do is to refuse the risk of any electrical installation which has not been carried out on his method; but even with the pats on the back which Mr. Bathurst gives these companies, and the wide technical knowledge which he almost considers as being their birthright, we are yet afraid he will be doomed to disappointment. The fact is, Mr. Bathurst, 12 months ago, came over from the United States, where rough and ready methods of installation work are characteristic; and he has even to refer to America for his fire insurance statistics and rules. In this country, however, slipshod and temporary work is the exception, and not the rule; and, in addition, we have the paternal guidance and supervision of the Board of Trade, and the excellent rules for, and energetic inspection of, installations by our engineers in charge of central supply stations.

That there is plenty of room for a good system of encasing wires in insulated tubes specially made for the purpose we do not wish to deny, and its introduction should meet with a large amount of success, but its advantages must be set out in a much more impartial and disinterested manner if the author wishes it to share any degree of serious attention at the hands of those who profess a knowledge beyond the mere rudiments of the requirements for good installation work. To condemn wholesale the present methods of wiring, as

Mr. Bathurst has done in his paper, indicates ignorance of the large and effective supervision under which work is carried out in this country, as compared with the supervision of the insurance companies only, which obtains in the United States.

A REVOLUTION IN COPPER MANUFACTURE.*

By HAROLD P. BROWN.

In these days of keen business competition, makers of electrical apparatus and machinery are quick to seize upon each advance in the arts which will reduce the cost of material or increase the daily output of their shops. And the alert engineers in our large electric power houses are always ready to adopt improvements which will effect a saving of power. Both these classes will, therefore, be glad to learn of a discovery in metal handling which will reduce cost and save time and power. It has been considered impossible to obtain solid castings of copper without mixing with it some other metal.

And it is well known that even ½ per cent. of alloy is enough to reduce the electrical conductivity of the casting to one quarter that of pure copper. Many processes of mixing or tempering this metal have been invented, but their product has not up to this time been able to show the physical properties of rolled or drop-forged copper. Some months ago in a new type of rail bond, I used strips of rolled copper with cast copper terminals. These castings were made for me by a firm which claimed extraordinary things for their product. I therefore expected very little from the metal, and in making tests was greatly surprised to find that a piece of this metal with but ⅜-square inch section, could transmit 1,500 amperes for 20 minutes without heating. A calculation based on this performance indicated a conductivity of at least 90 per cent. that of the best rolled copper. As I had never before found cast copper with more than 40 per cent. conductivity, and this only after compression, I decided to make a thorough and complete series of tests so as to ascertain the facts concerning this metal which is called MB copper. A chemical test suggested by Mr. Edison showed that these castings had less impurity than was contained in some sheet or rolled metal sold as pure electric copper. To exactly determine the relative conductivity, I ordered a pattern made from which I obtained castings of the best commercial copper and of the MB metal.

These castings were carefully finished so as to present for testing a cylinder 25 inches long and ·8 inch in diameter; a terminal was left at each end, about 2¼ inches × 2¼ inches × 1 inch.

As a basis for comparison I had an exactly similar bar turned up from the best rolled Lake Superior copper. The completed bars were magnificent pieces of metal without an apparent flaw. The difference in shrinkage of the two castings and a slight variation in the size of the terminals made it impossible to exactly obtain the comparative weight. The terminals of the rolled bar measured 2 inches × $2\frac{7}{16}$ inches × 1 inch, and its weight was 7 lbs. 6 ozs.

The commercial cast bar was a popular process "tempered" copper, with terminals $2\frac{1}{16}$ inches × 2¼ inches × 1 inch; its weight was 6 lbs. 9 ozs. The MB bar's terminals measured 2 inches × $2\frac{3}{16}$ inches × 1 inch, and its weight was 7 lbs. 1 oz. Each of the cast bars gave a clear musical tone when suspended and struck, the MB bar, though the heavier, giving the higher note. Of course, the rolled bar was without resonance. The commercial cast bar had accidentally been turned ·002 inch too small, but the other two measured exactly ·8 inch, thus having a section of practically ½ square inch.

I decided to test the electrical drop in 2 feet of each bar, and its temperature at from 100 to 1,500 amperes, the latter being three times the proper current for that section of copper. In order to prevent any rise of temperature from the contacts at terminals, each terminal was amalgamated by the Edison process, and coated with the Edison flexible solder; there was, therefore, no appreciable drop at these contacts. In amalgamating the commercial copper bar by the Edison process, fumes were given off with an odour of zinc, and a black precipitate was formed. This was washed off, and the process repeated several times, until the surfaces remained bright. Both of the other bars yielded instantly to the process, without fumes or precipitate.

Mr. Edison states that this is a keen test of the purity of copper, and so it proved, for analyses subsequently made for me by Ledoux and Co. showed the commercial casting to have 99·15 per cent. of copper, the rolled bar 99·83 per cent., and MB copper 99·85 per cent. In spite of the different characteristics of these bars, the variation in composition is less than seven-tenths of 1 per cent. From tests of similar samples, the tensile strength of the commercial cast copper was 19,000 lbs. to the square inch, while the MB was 30,000 lbs., which is practically the same as rolled copper.

The cables used for connections were 500,000 c.m., with triple braided insulation. When heavy currents were used, the bare ends of the cables near the bar connections were cooled with wet waste. The observed temperature of the bars was therefore not due to any outside cause. The instruments used were all made by Weston, and comprised a shunt ammeter reading to 1,500 amperes; a millivoltmeter reading ·0002 per degree up to ·01 volt; another reading ·003 per degree up to ·1 volt; and a third reading ·01 per degree up to 1·5 volts. In each case the same voltmeter terminals were used; these were clamped upon amalgamated spots on the bars, just 24 inches apart. A special dynamo, driven by Edison motors, was used; its field was excited from the Edison Mains; by using a rheostat and a bank of lamps, the amount of current generated could be accurately adjusted.

The first readings were taken at 100 amperes after about one minute's run; the current was then increased 100 amperes and a second reading taken, and so on until 1,500 amperes were reached. This amount of current was continued for ten minutes, and increase of the temperature and drop noted. The bars were then disconnected and laid upon a wooden floor, and their rates of cooling noted. Since the copper resistance tables are either calculated for a constant temperature, or were compiled years ago from data based on impure copper, I decided to use as a basis of comparison the drop of the rolled copper bar at each 100 amperes. Since the performance of the MB copper came so close to this standard, I repeated the tests on each, and found the readings accurately recorded. The tabulated results are as follows:—

Amperes.	Rolled copper.		MB copper.			Commercial "Tempered" cast copper.		
	Degs. F.	Millivolt.	Degs. F.	Millivolt.	Per cent.	Degs. F.	Millivolt.	Per cent.
100	71	·003	72	·0032	94	72	·010	30
200	74	·0065	72	·007	93	74	·023	30
300	76	·0105	72	·011	95	78	·037	28
400	78	·0134	72	·014	96	79	·046	27
500	79	·017	72	·017	97	80	·060	26·6
600	80	·0195	72	·020	97·5	82	·071	27·4
700	81	·02225	72½	·023	96·7	86	·086	26·7
800	81½	·025	73	·027	94·4	92	·096	26·5
900	82	·028	73½	·0295	95	96	·115	24·3
1,000	83	·03175	73½	·034	93·4	104	·130	23
1,100	83½	·035	74	·036	97	110	·145	24
1,200	84	·039	76	·040	97·5	118	·155	25
1,300	86	·042	78	·044	95	126	·165	25·4
1,400	88	·046	80	·048	96	138	·1825	25·2
1,500	90	·048	81	·052	92·3	150	·195	24·6
1,600	138	·053	136	·057	93	154	·220	24

The last set of readings was taken after a 10 minutes' run with 1,500 amperes.

The commercial cast copper averaged less than 28 per cent. conductivity, and before the end of the run, scorched the wood on which it rested and cotton covering the thermometer bulb, as it reached 354° F. and ·22 volt drop. Before the test the colour of this piece was fine, and closely resembled that of the other bars; after the test the bar was a mass of red and silver coloured spots, and had lost nearly all its resonance. At the end of the run it had expanded, from increase of temperature, ¼th inch in 24 inches and ·002 inch in diameter. Allowance should be made for its difference in size.

It required 2 hours and 20 minutes to cool to the temperature of the room. The rolled copper showed a conductivity far greater than called for by the tables ordinarily used. Its actual resistance per foot at 72° F. was ·000015 ohm. In the table published by the London Electrical Review, the resistance of a piece of copper, 95 per cent. pure, 1 foot long, with a section of ½ square inch, is said to be ·00001706 at 60° F. Without reducing to the same temperature, the latter resistance is $13\frac{7}{10}$ per cent. greater than the resistance observed. The tables based on the Matthiessen standard conductivity also show higher resistance; it is therefore wise to use an actual measurement of modern rolled copper as a standard of resistance for cast copper. The rolled copper bar at end of the 10 minutes' run with 1,500 amperes, reached 138° F. and ·053 volts. It had then increased ½-inch in 24 inches, as did the other, but the diameter increased but ·0005 instead of ·002-inch. It required one hour and 23 minutes to cool. The performance of the MB copper was a surprise, and remains a puzzle. In the tests it kept 8° to 10° cooler than the rolled bar up to a load of 1,400 amperes. At end of the 10 minutes' run with 1,500 amperes it reached 136° F. and ·057 volts.

The varying temperature of the two bars evidently accounts for the up and down movement of the efficiency curve. If in the tests the temperature of the bars should be kept at 72° by allowing time for cooling after each reading, it is my opinion that this curve would be practically a straight line at 95 or 96 per cent. I need not say that this conductivity is marvellous, and opens an entirely new field for dynamo and motor construction, and for switchboard work, where a large saving can be effected by using it in place of rolled or drop-forged copper, both of which will warp or twist when heated, while the finished cast metal retains its shape. I know of large multipolar dynamos upon which castings of low conductivity have been used for field coil connectors, &c.; on account of the unsuspectedly high resistance of these contacts, the calculations concerning compounding have been upset, and the dynamos have been failures. Another surprising quality of these MB castings lies in their elasticity. I have fastened in a vice one end of a casting 1 inch wide and ⅜-inch thick; the other end, 12 inches distant from point of support, was bent 1 inch out of its position, but sprang back when released. I have driven through a ⅝-inch hole in a hardened steel plate a plug of MB metal $\frac{37}{64}$-inch in diameter. This required as many hammer blows on the fifth trial as it did the first.

In another experiment I drove into an opening $1\frac{9}{16}$ inches wide, between heavy steel rails, two plugs of MB copper, the sum of whose widths was $1\frac{19}{32}$ inches, thus compressing the metal $\frac{1}{32}$-inch, or about 2 per cent. A current of 1,500 amperes was then passed through the junction, whose section was ⅜th square inch, and a drop of ·018 volt was indicated from rail to rail through the two copper plugs in series.

* The *Street Railway Journal*.

The rails were then separated $\frac{1}{32}$-inch more, but the drop remained the same. An analysis of another sample of this MB copper gave the following results:—

Copper	...	99·870 per cent.		Bismuth	None.
Silver	...	·034	,,	Lead	,,
Iron	...	·011	,,	Cobalt	Trace
Arsenic	...	·002	,,	Sulphur	None
Zinc	...	·015	,,	Oxygen (by difference).	
Tin	...	None	,,		·068 per cent.

This analysis is verified by others made by such experts as Ledoux and Co., Garrett & Blair, Prof. Frank X. Moerk, and others, and show exactly the same results as the best Lake Superior copper. It is evident that no alloy has been used. And yet the process has increased the electrical conductivity and the tensile strength; has given a certain amount of elasticity and decided resonance; has increased the density and changed the structure of the metal.

On presenting this matter to Mr. Edison, he accounted for the evident change in the structure of the metal by the theory that the shape of the crystals had been altered so that their lines were parallel, and that the molecules were thus brought closer together, and into more intimate contact with each other.

The fact that MB copper can also be rolled or forged adds new interest to its development. Since its tensile strength exceeds that of ordinary copper wire, it is certainly worth while to make wire from it in order to determine its strength and conductivity when in this shape. If it is possible by this process to make as large an increase in the conductivity of wire as it has made in conductivity of cast copper, it would revolutionise dynamo and motor building, and every electric light and railway company would save money by using it to replace its present line wire. And if the tensile strength of the wire is increased by this process, poles can be set further apart, and the wire will be less likely to decrease its diameter during winter.

It is understood that Mr. Edison is interested in the development of the process, and that MB copper will be manufactured under his supervision at the Menlo Park Works.

LABOUR SAVING MACHINERY THE SECRET OF CHEAP PRODUCTION.

Some figures recently advanced by Mr. A. E. Outerbridge in the *Engineering Magazine* are interesting as showing the results of the use of labour saving machinery in producing articles on the interchangeable system. Thus in the watch trade, some years ago, the yearly average production of the Swiss workman was 40 watches, while in America 150 was the average, and we believe it is only because of the use of similar machinery that the Swiss have been again able to outdo the Americans.

In the small operations of the watch factory a day of hand labour was 30 pillars cut and set. The Elgin pillar cutter produces 2,000 per day to one operator. In certain wheels 1,200 with a total of 96,000 teeth, are produced daily by one cutting mill at 7,000 revolutions per minute.

One man can turn out 1,200 screws per day of such a fineness that 100,000 of them go to 1 lb. In a small watch the pallet-arbor, which weighs $\frac{1}{130000}$th of a pound, undergoes no fewer than 25 operations. It has a thread of 260 to the inch. It is gauged to the $\frac{1}{25000}$th of an inch, and its cost is 2¼ cents (1½d.).

There are 80 separate operations on a balance wheel, 66 of these being drilling, tapping and countersinking of holes, yet such a wheel only weighs 7 grains. In such small operations drills run at 48,000 per minute and one operator drills 2,200 holes per day.

The aim of all such work seems to be to have every machine as simple as possible. Those ingenious machines which can be lathe, boring mill, drill, planer and miller by turns, find no place in the specialised factory where every job is as simple as possible, and is allotted a machine to itself, and this machine is fitted to do one and only one piece of work. Hence the large number of operations to each piece. It is not a little curious to note how backward the Americans have been until lately in the provision of facilities for lifting work to machines. Heavy articles would be laboriously carried by labourers to modern labour saving tools. Now, however, the provision of cranes and travellers is universal in all good works, and the electric crane of 10 tons capacity recently erected in a certain department of a locomotive works is credited with saving £20 per day. In another case two electric cranes dispensed with 60 labourers. A modern locomotive finished complete costs less than 3½d. per lb.

A great feature in economical working is the abolition of all tools as soon as better are to be had. Mr. Outerbridge contends that American productions will soon very largely compete in Europe. If there is a more stupid fellow than an old world manufacturer in sticking to out-of-date tools, it is the American who sticks to an out-of-date commercial policy, and is so ignorant that he really does believe McKinley to be his worldly saviour. So long as European manufacturers have the existing type of ignorant Americans to compete with they may feel safe, for no tariff-protected man is ever anything at heart but a coward. But there are signs that even in America the folly of tariffs is becoming known, and when a different policy prevails there will be a change in the severity of American competition. At present it arises largely from the fact that the American home trade is crippled by protection, and surplus is sold in Europe at less than American prices. American manufacturers trading on this side find in England more particularly that there is no prejudice to contend with. The use of American products does not cause irritation as does the use of English products in America, and so long as an article is good it will be bought. This is a feature that commends itself to American manufacturers who are seeking more and more to do trade with the despised European, and the future will show increased competition. The labour in American factories is also under much stricter control than in Europe, or at least in England. There is no control by trade unions which, often beneficial, has too frequently led to very foolish restrictions being placed upon output, and while we would not care to advocate the nigger-driving of American shops we think there is room for greater effect to be produced here without encroaching upon that limit of reasonable endurance which is so frequently exceeded in America, and has been one of the factors in the production of the tramp disgrace. Increase of output is all very well up to a point, but when the use of labour saving machines is only able to assist to compete by driving labour beyond the limit of physical endurance we seem to see a reason for asking why an attempt should not be made to cheapen production by enabling a man to purchase more with a wage of $10 than he now can with $15. Contrary to general belief we do not believe that the average American wage is equal to the average English wage in purchasing power. There must be therefore something rotten in the conditions which reduce an apparently high pay to a really low or moderate pay when reduced to the datum line of purchasing power.

THE PIONEER LONG BURNING ARC LAMP.

It may be of interest to our readers to learn more of the details of an enclosed arc lamp, which we are informed is soon to be put on the market here. The lamp is made by the Electric Arc Light Company (Incorporated), of New York City, and is known as the "Pioneer." The makers claim to be pioneers in enclosed arc lighting in America, and that the "Pioneer" lamp embodies the latest improvements in the art of enclosed arc lighting. That the lamp has gained a firm foothold in America may be inferred from the testimonials that appear in the company's catalogue, and

Fig. 1.—Arc Enclosing Parts of "Pioneer" Lamp.

we are informed that there are over three thousand (3,000) "Pioneer" enclosed arc lamps in successful daily operation in the City of New York alone—more than half of the total number of lamps in use in London.

In our issue of February 5th, 1897, we presented a cut of the Pioneer indoor lamp, and described the action of the mechanism. In addition to this, we give herewith a separate view of the gas-check plug, bulb, and lower carbon-holder (fig. 1).

The gas-check plug is the latest invention contributed by Mr. L. B. Marks, M.M.E., who is the chief electrician to the Electric Arc Light Company, to the field of enclosed arc lighting. The new gas-check plug of the "Pioneer" lamp avoids the use of double globes, thus saving the light necessarily cut off by the outer globe. The company claims to obtain in this way at least 25 per cent. greater output in available light produced per ampere of current than has been found possible by any other means. This plug closes the mouth of the small globe, and consists of two parts so arranged as to form a chamber to retain the carbon gases developed by the action

of the arc. The arrangement is shown in fig. 2, where the plug is represented mounted in a globe. It will thus appear that the chambered plug serves as a substitute for the outer globe, the function of each being the same—namely, to act

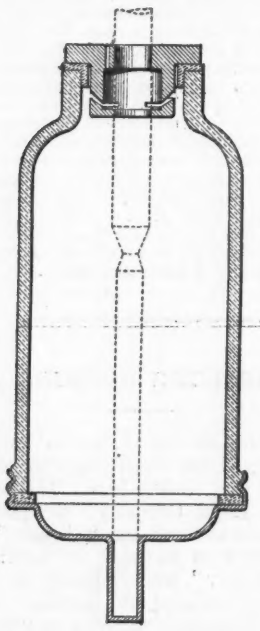


Fig. 2.—Enclosure with Gas-check Plug.

Fig. 3.—The "Pioneer" Enclosed Arc Lamp for Outdoor Use.

as a reservoir for the inert gases. If it be desirable to obtain still greater diffusion, a light opalescent outer globe may be used. For street lighting, and in other cases where the lamps are exposed to the action of the elements, an outer globe is provided, as shown in fig. 3.

With lamps of this kind, in which the arc is always long, the distribution of light is quite different to that of an open arc, and there are, it is said, no shadows on the globe of the "Pioneer" enclosed arc, and the degree of illumination is almost absolutely uniform.

BOILERS AND BOILERS.

An article of very great interest to the users of steam power, whether in central electric light or tramway stations, appears in the March issue of *American Machinery*.

The writer, Mr. Barnet Le Van, is well known in technical circles, and his subject is "Water-Tube *v.* Shell Boilers." After referring to tests, for proof of economy, made at the Centennial Exhibition, in which the Lowe and Galloway shell boilers are compared with the Root and Babcock and Wilcox water-tube boilers, Mr. Le Van shows, from a tabular statement of the results obtained, that the shell boilers' evaporation was better than that of the water-tube boilers, and the former had less moisture in the steam supplied. But the best comparative tests were made some years ago between water-tube boilers and shell, or horizontal flue, boilers at the establishment of the Brush Electric Light Company, Philadelphia.

The Babcock & Wilcox people were anxious to supply the Brush Company with boilers, and to show their superiority over the ordinary horizontal flue boilers, so to convince the managers of the above company that it would be to their interest hereafter to renew their plant with water-tube boilers in preference to those of the horizontal flue type they were using, the Babcock & Wilcox firm proposed, and conducted, a test, under the supervision of Mr. John C. Hoadley, of Boston, Mr. Le Van acting on behalf of the Brush Company.

It was agreed that exactly similar trials should be made of the two kinds of boilers, each set to be tested for three consecutive days. During the trial of the water-tube boilers the firing was performed by two firemen, one of them opening and shutting the fire door for every shovelful of coal placed on the grates by the other fireman, who was also assisted, at times, by a third individual acting under the directions of Mr. Hoadley.

During the trials of the horizontal flue boilers, the firing was done throughout by a single fireman, unassisted. We cannot spare the space to give the complete conditions of the tests nor the details of carrying them out, but we may briefly state that the water-tube boilers were pushed to their utmost capacity, and that in five trials they failed twice to fulfil the conditions of the test; whereas the flue boilers ran their three days without a hitch, although the load was more than 7 per cent. above that of the others.

The capacity being the evaporation of water per hour, the following result was found:—

Horizontal flue boilers	...	6,507 lbs. of water
Water-tube boilers ...	...	5,894 „ „

or a gain of 9½ per cent. in favour of the horizontal flue. So far as the quality of the steam was concerned in regard to its humidity, the horizontal flue had the advantage by 4½ per cent.

The economy being determined by the lbs. of water evaporated per lb. of combustible, we find :—

Horizontal flue boilers	...	12·3 lbs. of water.
Water-tube boilers ...	...	11·4 „

7·3 per cent. in favour of the former.

The two Babcock & Wilcox boilers were rated as 75 horse-power each, total 150 H.P., and the three horizontal flue boilers were of 35 horse-power each, total 105 H.P.

Square feet of heating surface, B. & W., 1,592; H.F., 1,248.
Horse-power developed ... B. & W., 128; 138.

Mr. Le Van thus concludes: "The steaming capacity of a boiler is usually expressed in horse-power, as with the engine itself, and the horse-power is taken to be equal to evaporation of 30 lbs. of water, *an evaporation of 30 lbs. of water per hour from a feed water temperature of 100° Fahrenheit into steam at 318·4°, or 70 lbs. gauge pressure*, which may be considered to be equal to 34·5 lbs. of water evaporated from,

and at 212°. 30 lbs. of water converted into steam, although a convenient unit of measurement so far as the boiler is concerned, does not indicate the power of the engine. The best modern engines exert an indicated horse-power per hour with less than 20 lbs. of water, whereas some engines largely sold have been found to use over 60 lbs. per hour per horse power.

"Square feet of heating surface is no criterion as between different styles of boilers; a square foot under some circumstances being many times as efficient as in others. In the tests at the Brush Electric Light Company's, the horizontal fine boilers developed a horse-power for each 9·4 square feet of heating surface, whereas the water-tube boilers required 14·1 square feet, a difference of *33 per cent.*, or in other words, the water-tube boilers required 33 per cent. more heating surface to develop the same power that the horizontal fine boilers required."

Full details of the trials to which we have alluded can be found in the journal from which we have extracted the above particulars.

THE NATIONAL TELEPHONE COMPANY'S DINNER.

The fourth annual staff dinner of the National Telephone Company was held at the Trocadero Restaurant on Friday last, and was in every respect a function of the greatest interest. Although one does not usually refer to the dinner itself, an exception ought certainly to be made on this occasion, for it was of an exceptional character, the catering and service being praiseworthy in the extreme.

Mr. Wm. E. L. Gaine, the general manager of the company, occupied the chair, and was supported by Mr. J. Staats Forbes, Lord Harris, and other directors of the company. Among the guests were Mr. W. H. Preece, Mr. J. C. Lamb, Prof. Hughes, Sir Henry Mance, and Sir Robert Hunter. After the usual loyal toasts had been honoured, the chairman in submitting the toast of the National Telephone Company, said the company had not been altogether inactive during the past year. They increased their *clientèle* last year by 9,000 people, but this year it was not far short of 13,000. They opened in the previous year 50 new exchanges throughout the country, but this past year they had opened 69. Last year they were only sending 313 million messages, but this year they were sending 350 millions, an increase in the 12 months of 37 millions, or about half the number of inland telegrams. Since they last dined together, the trunk wires connecting all the various telephone areas and towns throughout the kingdom had passed from the control of the company to the control of the State. That had been no light matter, but having regard to the magnitude of the transfer there had been a minimum of dislocation and inconvenience to the public, a result which was due to the loyal co-operation of both parties to the transaction. Referring to the adoption of the twin wire, the chairman mentioned the many towns that were working on this system, as well as those places where difficulties existed. Negotiations were being carried on with the constituted authorities which would enable them to lay the bulk of their wires in London underground.

Mr. James Staats Forbes, in responding, said there was no commercial organisation which was more delicate and more difficult to direct than the telephone. They were in a somewhat anomalous position—they were practically the agents of a great public department, but they had no legal rights. The telephone company was working out a problem of vast importance to the whole community, but the success of the company depended upon elements of the personal kind, and unless there be between the board of directors, the directing power, and the hands that achieve the result, a personal sympathy, it could never succeed. After referring to the critics, the speaker went on to say that their charges were practically 6d. a day for the use of a most marvellous invention, and in a few years hence no man would be perfect without the telephone, and some day the public would awake to the truth of that.

Mr. W. H. Preece, in proposing the toast of "Telephony," said that exactly 20 years ago the Postmaster-General of that day commissioned Mr. Fischer and the speaker to proceed to America for the purpose of inquiring into the invention of a curious instrument that transmitted the voice from one end of the land to the other. He went determined to expose the fraud, but had not been in the company of Graham Bell five minutes before he became an ardent believer, and ever since then the Apostle of the telephone. Comparing the receiver of to-day with what he brought from the States 20 years ago, there was not very much difference. In extending the use of the telephone in this country they had to encourage mutual assistance between the suppliers and the subscribers. The system was growing very rapidly in this country, and although the trunk wires had fallen into the hands of the Post Office, there were more trunk wires being operated in this country than in the whole of Europe. In Germany there were 583 trunk wire circuits in operation; in England there were 881, and of this number it was very rare to find in one day that eight or nine had failed. They had not been idle in this country, in spite of criticism and opposition. If they looked to the United States, beyond the introduction of the multiple board, he did not know that much development had taken place since the early days. In this country the telephone had been made practicable by the microphone of Prof. Hughes, the metallic circuit question had been fought out here, and the elimination of disturbance in telephone circuits by twisting the wires shown by Prof. Hughes, and the possibility of underground and submarine cables had been shown here, as well as automatic and visual signalling.

Sir Henry Mance, in replying to the toast, said electrical men could claim to have contributed a great deal to the Victorian era. Although telephones, like telegraphs, were not friendly with tramways, there was no reason now that metallic circuits were being adopted that they should not bury the hatchet.

Mr. Dane Sinclair, in responding for the same toast, mentioned that Mr. Preece had omitted from his list of developments in this country, duplex telephony; indeed, they were using a great deal more duplex telephony than any other country.

Lord Harris proposed the "Post Office," which was responded to by Mr. J. C. Lamb, and Mr. A. E. Cottrell proposed "The Guests," which was acknowledged by Sir Robert Hunter and Prof. Hughes.

One of the agreeable features of the evening was the rendering of an excellent programme of music, the various items being given by Mr. R. E. Miles, Mr. Harry Stubbs, and Madame R. Tester Jones.

GLOVER'S NON-FIBROUS WATERPROOF DIATRINE CABLE.

It is a well-known fact that all compound fibrous cables depend upon their lead covering for durability. As soon as the lead covering becomes faulty, a breakdown with its serious consequences is the result, and a similar mishap will also occur if water can get through to the conductors at the leading-in of the lead covered cables into boxes. The compounds used for impregnating fibrous substances, such as cotton, jute, &c., may be waterproof themselves, but this does not alter the fact that the water or dampness travels gradually along the fibrous threads or fibrous substance used as a basis for the insulation. Lead cased fibrous cables are all the more to be avoided if the compound used for impregnation is not waterproof, and too little care is sometimes manifest in choosing the materials for the manufacture of such compounds or oils. Any substance forming hydrates in contact with water should not be used, as the smallest quantity of water which may, for instance, get into a badly secured end of the cable, naturally causes decomposition of the insulation, and frequent breakdowns are the consequences. The disadvantages and faults of the existing oil or compound

fibrous cables have given rise to continued experiments in one department of Messrs. Glover's cable works, and have led to the manufacture of a rubber-like material which, it is claimed, overcomes all the faults of compound cables, at the same time combining extraordinary cheapness with very superior electrical and chemical qualities. The firm has succeeded in producing what may, we think, be said to be an absolutely waterproof non-fibrous material, the insulation of which is not dependent upon its lead covering, which does not absorb moisture, and stands high tension currents for a given thickness of dielectric to a greater difference of potential than any other cable we have seen. The cable insulated with Messrs. W. T. Glover & Co.'s new non-fibrous diatrine is very flexible, and of considerable mechanical strength. A strand covered to $2\frac{3}{4}$ mm. thickness with this material withstands 25,000 volts alternating current pressure, after having been submitted to Mr. Wordingham's bending test, according to which the cable is to be wound round a drum of 2 feet in diameter, three times forwards and three times backwards in a reversed way. The lead covering was stripped off another length of cable, the cable immersed in water, and tested with 35,000 volts after 16 days' immersion. We, ourselves, have tested a section of this waterproof cable, and herewith give the following figures:—

A length of 202 yards of 61/12^s strand single cable, insulated with Glover's non-fibrous waterproof diatrine to a thickness of $2\frac{3}{4}$ mm., or 110 mils. gave the following insulation tests.

Battery used = 600 volts. Constant 762,000 megohms. Insulation resistance:—

	Deflection.	Megohms per mile.
1st min.	282·5	309
2nd min.	203·5	429
3rd min.	172·5	507
5th min.	148·5	589
6th min.	140·5	622

Temperature 58° F. All readings perfectly steady.

It will be seen from the above tests that the electrification of the cable is remarkably good.

We then tested a piece of the same cable, a few yards in length, without lead covering, in water (after 19 days immersion) with H. T. alternating current of 80 ~ up to between 35,000 and 40,000 volts, the highest tension we could obtain with the testing transformer at our disposal, but failed to break down the cable, although the rubber covered lead, which, by the way, had been in use for many months, was finally ruptured.

At the same time we had occasion to inspect Messrs. W. T. Glover's new method of preserving the steel tape covering with which they armour their non-fibrous diatrine and other cables.

The present state of an armoured cable, after having been in the ground for a few months, shows that the steel tape is in most cases completely corroded, so that it does not further protect the cable from external injury. To prevent this corrosion setting in the steel tape is served on both sides with a preservative quick-drying paint, which resists water and the effect of diluted acids. The paint covers top and bottom of the strip, so that no inroad on the metal can take place. Central station engineers might prolong the life of the armouring of their conductors, and therefore that of the lead covering and cable, by insisting upon the steel strip being homogeneously served with such a preservative material.

Is it possible to bring into existence a good artificial substitute for India-rubber? This question, with which a contemporary, last week, opened up a series of comments upon cycle tyres, is one which has long agitated the minds of cable manufacturers. We do not say Messrs. Glover have gone so far as this, but we do assert that they have succeeded in producing an insulating material which appears to possess all the essential qualifications needful for electric lighting work, if, indeed, it is not eventually found applicable to telephonic and telegraphic purposes both subterranean and submarine, and which has also the very desirable merit of cheapness.

The durability of the material remains yet to be proved, and this, of course, time only can determine. Everything must, however, have a beginning, and diatrine, we are free to confess, promises well at this stage of its existence.

CORRESPONDENCE.

Theory of Constant Speed Direct Current Motors.

In his reply to my remarks on his paper on the above subject, which appeared in your issue of February 26th last, Mr. Rhodes asks me to point out the "obvious clerical errors" which I before passed over. These were, in the substitution of his equation (6), in equation (2), p. 271, where 4π, &c., becomes 2π, &c., and again in all of the succeeding equations the same error is repeated. Also between equations (16) and (17) we have "eternal" for "external."

Mr. Rhodes then shows that if the reluctance varies, the speed will also vary in the same way. But this is quite beside the question. In the original article he makes the assumption that the magneto-motive force varies as the magnetic flux; but anyone who knows anything of circuits containing iron knows that this cannot be the case except for a very short part of the β H curve, and then only at a certain value of β depending upon the quality of the iron—viz., the point of maximum permeability.

As to what would be the exact percentage variation in the reluctance between no-load and full-load is easily found by anyone knowing the data of the machine. I am afraid I have already occupied too much of your valuable space, or I would gladly show Mr. Rhodes how this can be done.

With regard to the example, I am sorry I misunderstood Mr. Rhodes to say that the motor was for 10 kw.; but my knowledge of dynamos is confined to those made of iron or steel and copper, and does not extend to those made of paper or other non-magnetic materials.

In the former class the value of the maximum possible output is both unknown and uninteresting unless pyrotechnic display is the object sought.

As I still fail to understand fully his example, but perceive that the motor therein-mentioned has several novel features, may I suggest that the publication of the working drawings with all necessary data would be interesting?

In conclusion, permit me to say that I do not dispute Mr. Rhodes's results if we grant his assumption (as I have already had the pleasure of telling him personally). But what I point out is, that the formula given for compounding gives a result which may be very wide of the mark when the change of reluctance is allowed for.

Samuel Joyce.

Latchford House, Manchester,
March 12th, 1897.

Postscript.—Please correct the following printer's errors in my own article on p. 344, just above equation (1):—

$$C_a e_o = \text{F and } e_o = \frac{N_o n w}{10^8}$$

should read

$$C_o \varepsilon_o = \text{F and } \varepsilon_o = \frac{N_o n w}{10^8}.$$

S. Joyce.

I have to thank the Editors of the Electrical Review for forwarding proofs of a second letter by Mr. Joyce.

In his former letter Mr. Joyce fixed upon variations of reluctance as an objection to my article on constant speed motors. In my reply last week I showed that it is only the necessarily small percentage change of the total reluctance which affects the speed. With strange inconsistency, my critic now says that this is beside the question. It is also odd that he should regard the maximum output of a motor as a matter of no interest, since for certain classes of work it is an important factor.

Perhaps the most prominent element of Mr. Joyce's letter is the spirit of declamation which pervades it, and which renders further argument useless, since it would only lead to *eternal* resistance, to quote one of the clerical errors which he has been good enough to point out.

W. G. Rhodes.

Salford, *March 17th*, 1897.

Alternator Test.

In recently testing the governors of a 300 kw. direct coupled steam alternator, an artificial load was used consisting of a water resistance.

The machine easily developed 150 amperes at 2,100 volts.

When placed on the town load, with the same steam pressure and speed, the plant would give no more than 135 amperes at 2,080 volts.

Is it correct to assume that the self-induction of the town load would account for the *extra* power required to develop the same apparent output as the machine gave on the non-inductor tank load?

Assistant.

[The effect of induction on a circuit is to make the apparent watts greater than the real watts. Therefore a given horse-power will give *larger* readings on the town circuit than on a water resistance. A probable explanation is that the instruments used were not identical in calibration. Alternators designed to work on a mixed load—partly lamps and partly motors—have more copper in their armatures than those designed simply for lighting; this is to provide for the excess current which does not represent power.—Eds. Elec. Rev.]

The "Rapid" Cable.

Mr. David Cook appears to have misunderstood me when I wrote that "it seems remarkable that no one should have discovered earlier the extraordinary power which distributed leaks possess in accelerating speed—if Prof. Thompson's expectations are to be realised."

My meaning is fully explained by a previous paragraph:—"Although it is generally accepted that a fault or 'leak' in a long cable, by facilitating discharge, improves the definition between signals, and therefore increases the speed somewhat, it certainly was not anticipated that 'an Atlantic cable with three stretches, such as I have described, would transmit signals four or five times as quickly as the best single core laid, while with five it would transmit seven or eight times as quickly." In other words, while I am fully aware that leaks can increase speed, the results of my experiments on an artificial cable, so far as they are comparable, do not seem to promise the very great increase in speed for the twin core cable recommended by Prof. Thompson. What the maximum increase in speed due to leaks may be for a given working current will, without doubt, depend on the length of the cable, the resistance of the leaks, and their distribution; but whether "you can *double* the speed by proper leaks and still have enough current to work by," as Mr. Oliver Heaviside is said to have stated, is an altogether separate consideration; and as I am unable to prove this by experiment, I am not disposed to question the calculations of so high an authority. Such a result, however, as well as the conditions specified by Mr. Heaviside, differ very widely from those of Prof. Thompson, as recently published in the *Pall Mall Gazette* and quoted above. To *double* the working speed of an Atlantic cable is without doubt a consideration of the highest importance, but if equal in length to (say) one of the Commercial Company's cables (2,346 knots) and having an insulation resistance of 1 megohm per knot, as suggested by Mr. Heaviside, the resulting total insulation of only 426 ohms would increase very seriously the difficulty of localising faults.

J. Rymer-Jones.

Commutatorless Continuous Current Dynamo.

In speaking about "flux of force," it seems to us that the following points are usually forgotten:—

1. That it is the bodies themselves which act one upon the other, a flux of force being only the measure of that action at a point.

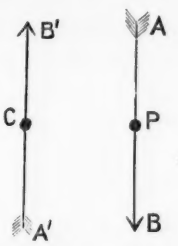
2. That one body in order to move another *must act as its fulcrum.*

In other words, it seems to be forgotten that one material point cannot exert a force upon another material point in any other direction than that of the straight line joining them.

For example, in electro-magnetism it is said that if *c* is a rectilineal conductor perpendicular to the paper, and carrying an electric current, and P a magnetic pole, *c* will tend to make P move in the direction of the arrow A, B, and P will tend to make *c* move in the direction A′, B′. This, it will be seen, is impossible, because there is no fulcrum in either of the cases.

Speaking generally, *all the pretended actions of one body upon another are impossible, if they cannot be explained by the resultant of the attractions or repulsions in a straight line of each point of the one body upon each point of the other.* Our opinion is, that in the similar actions between conductors and magnets every portion of the conductor acts as the fulcrum for the rest of the system.

These considerations have led us to make a non-polar dynamo, in which the bars wherein the electric current is induced revolve with the inductors, which renders the construction very simple and very strong.



The fulcrum of the whole mobile system is here the *external circuit, i.e.*, the fixed part of the electric circuit mains, &c.

The result of these reasonings is, that we are now able to make a commutatorless continuous current dynamo, essentially practical and strong, giving a very high efficiency, working without attendance, and without sparking, no matter what fluctuations there may be in the load—a very important point in a great many cases.

A. De Puydt and M. Poncin.

[If the efficiency of the commutatorless dynamo depends upon the above reasoning (?) we have but little hope of it.—Eds. Elec. Rev.]

ANSWER TO CORRESPONDENT.

J. R. Wilson.—By ohm's law, $C = \frac{E}{R}$, or, $R = \frac{E}{C} = \frac{100}{22}$ = 4·5454 ohms, *i.e.*, we have a potential difference of 100 volts between the ends of a resistance of 4·5454 ohms. If now we introduce a resistance of ·3 ohms, then the 100 volts difference of potential will be between the ends of a resistance of 4·5454 + ·3, or 4·8454 ohms, consequently the potential difference between the ends of the 4·5454 ohms portion of the resistance in circuit will be $100 \times \frac{4{\cdot}5454}{4{\cdot}8454}$ = 93·82 volts, *i.e.*, the reduction of E.M.F. will be 100 − 93·82, or 6·18 volts. It may be added that the current will also be reduced, *i.e.*, it will now be $22 \times \frac{93{\cdot}82}{100}$ = 20·64 amperes.—Eds. Elec. Rev.

BUSINESS NOTICES, &c.

Bankruptcy Proceedings.—Under the failure of Mayner, Handford & Co., electrical engineers, St. James Street, Westminster, and Brighton Works, Red Hill, the debtors attended last Friday at the London Bankruptcy Court, and were allowed to pass their public examination upon accounts showing gross liabilities £4,675 3s. 6d. (unsecured £3,795 13s. 4d.), and assets estimated to produce £1,500 18s. 1d. The Official Receiver examined the debtors at some length upon the further accounts that had been filed, and especially regarding certain alleged preferential payments made shortly before the failure. The debtors explained the payments by stating that the sums in question were in discharge of cash advanced without interest being charged, and in their opinion they were justified in so acting, although trade creditors were at the time pressing for payment.

The first meeting of creditors was held last Friday, at the London Bankruptcy Court, under the failure of W. A. Fraser, electrical engineer, 18, Cecil Court, Charing Cross Road, W.C., and at Guildford. The debtor, who has been financed by his father, commenced business in May, 1895, with a borrowed capital of £250. He traded at first in partnership, but subsequent to August, 1895, he had the whole interest. The business did not pay, and was abandoned in July, 1896, the Guildford branch having been started in the previous November. Loss on the trading was the cause given for the failure.

The Chairman said there was very little chance of a dividend, as the assets were only valued at £15 18s., and the liabilities amounted to £904. Acting under a summary order, he would administer the estate in bankruptcy.

Electrical Wares Exported.

Week Ending Mar. 16th, 1896	£	s.	Week Ending Mar 16th, 1897.	£	s.
Adelaide	25	0	Alexandria	50	0
Alexandria	63	0	Amsterdam	200	0
Algoa Bay	177	0	Antwerp	21	0
Amsterdam	80	0	„ Elec. fuses...	307	0
Bangkok	177	0	Baltimore. Teleph. mat.	50	0
Bilbao	19	0	Bombay	24	0
Bombay	116	0	Bushill. Teleg. mat. ...	33	0
Brisbane	93	0	Calcutta	88	0
Cape Town	573	0	Cape Town	335	0
Delagoa Bay	885	0	Christiania. Teleg. wire	45	0
East London	1,346	0	Colombo	10	0
Flushing	18	0	Copenhagen. Teleg. wire	20	0
Gothenburg	12	0	Durban	796	0
Hamburg. Teleg. mat.	512	0	East London	279	0
Hong Kong. Telephone mat.	27	0	Genoa	160	0
Liban	417	0	Gothenburg. Teleg. wire	310	0
Melbourne	184	0	Hong Kong	14	0
Novorossisk	132	0	Jersey. Teleg. poles ...	14	0
Passages	198	0	Lisbon. Teleg. mat. ...	12	0
Port Natal	281	0	Melbourne „ „ ...	45	0
Reval. Teleg. mat. ...	193	0	Ostend	33	0
Shanghai	6	0	Paris	10	0
Singapore	32	0	Rangoon. Teleph. mat.	48	0
Sydney	293	0	Shanghai	63	0
Wellington	126	0	Singapore	75	0
Yokohama	80	0	Stockholm. Teleg. mat.	125	0
			Sydney	1,638	0
			Wellington	337	0
			Yokohama	2,000	0
Total	£6,065	0	Total	£7,142	0

Foreign Goods Transhipped.

	£	s.
Bombay	150	0
Total	£150	0

Books Received.—*Practical Electrical Measurement*, by E. H. Crapper. Published by Messrs. Whittaker & Co., London.

The Elements of Electro-Chemistry: Treated Experimentally. By Dr. Robert Lüpke. Translated by M. M. Pattison Muir, M.A. Published by H. Grevel & Co., 33, King Street, Covent Garden, W.C.

Change of Address.—Messrs. Willans & Robinson inform us that the offices of the company will be removed from Thames Ditton to Rugby, Warwickshire, on March 18th. All letters and other communications posted after March 19th should be addressed to Rugby. After the 18th the works at Thames Ditton will be used only for the manufacture of certain standard parts of the engines. Engines will be erected and tested at Rugby, and no correspondence will be conducted from Thames Ditton. Every effort will be made to prevent interruption of business in consequence of the move, but the company asks the indulgence of customers and correspondents in regard to any unavoidable delay which may arise, either in replying to letters, or in giving delivery of engines on order.

Dissolution of Partnership.—Messrs. A. Cafferata and W. H. Aspinall, carrying on business at Liverpool as electrical engineers under the style of Cafferata & Co., have dissolved partnership by mutual consent. Debts to be attended to by W. H. Aspinall.

Fireproof Flooring for the Central Station.—The stand taken by the fire insurance companies in respect to electricity supply works and electrical factories has been a subject for discussion among electrical engineers, particularly central station men, for some time past. How to get out of the difficulty, whether by mutual or other insurance scheme, is anything but an easy matter to settle. There is, however, one point upon which electrical engineers seem to be unanimous, and that is that it is eminently desirable that no stone should be left unturned to render central station and electrical factories as fireproof as possible, and to have the minimum of inflammable material about such premises. To effect this object, we commend to the notice of central station engineers a catalogue which has been issued of the "Mark Fawcett" fireproof floor, by Messrs. Mark Fawcett & Co., of 50, Queen Anne's Gate, Westminster, S.W., who have, we understand, put down much of their fireproof flooring in America and this country.

Gas.—On Saturday last a gas explosion occurred at Lordship Lane, East Dulwich, wrecking several rooms, and on 16th inst. a similar explosion occurred at Aberdeen.

Liquidation Notice.—A general meeting of the members of the Weybridge Electric Supply Company will be held at the offices of the British Thomson-Houston Company, Limited, 83, Cannon Street, E.C., on April 14th, at 12 o'clock noon, for the purpose of having an account of the winding up proceedings given by Mr. J. S. Lobb, the liquidator.

London Agent.—Messrs. McClure & Whitfield, of the Mersey Dynamo Works, Heaton Lane, Stockport, inform us that Mr. A. Montagu Shepherd, of 68, Victoria Street, W.C., has been appointed their London agent.

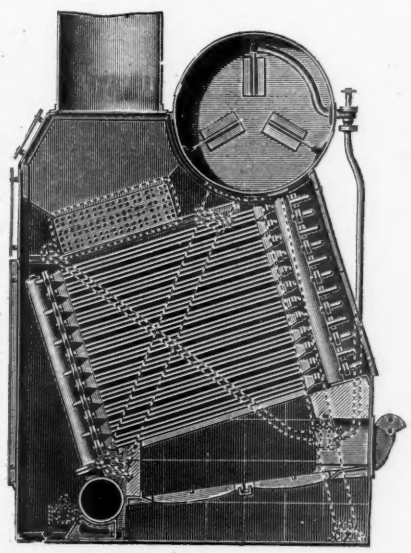
Newcastle-upon-Tyne Electrical Exhibition.—Some time ago we published an article describing the process of lamp manufacture as carried on by the Sunbeam Lamp Company, Limited, of Gateshead-on-Tyne, and we also gave some details of the works. This company is very much in evidence at the Electrical and General Engineering Exhibition at Newcastle-upon-Tyne. The whole of the lighting by incandescent lamp is carried out with lamps manufactured by this company. At their stand are exhibited lamps of every description, from the tiny battery lamp to the large 3,000 C.P. lamp, including lamps for high voltage circuits. A very artistic and novel way of showing their trade mark is in the form of a vacuum tube representing the Sunbeam lamp and shade, which gives a very pleasing effect; the name "Sunbeam Lamp" is made with small frosted lamps in series. To interest the general public a few beautiful vacuum tubes of fancy shapes are running, and also a display of "X" ray focus tubes, all manufactured by the company. We understand from the secretary that very great progress has been made by this company since commencing the manufacture of small lamps, inasmuch as twice they have been compelled to make extensions to their works, and at the present moment the directors have again under consideration further developments to enable them to cope with the orders.

Our Foreign Trade.—The British manufacturer, if he has his eyes well open to business, is just now taking advantage of every reasonable chance that occurs to him of bringing his wares before the notice of buyers and users abroad, particularly in the English Colonies. For the purpose of affording an additional opportunity in this direction, there have been published by the A B C Export Guide Company, of 165, Fenchurch Street, E.C., guides intended for the use of foreign and colonial buyers. The first series consists of three books (2s. each) giving a list of the principal manufacturing exporters in this country who make a specialty of exports suitable for the South African, Australian, and Eastern (India, China and Japan) markets. Each of these books has also some good hints for dealers with the respective countries, which are stated to be the outcome of practical experience. We will not venture to deal with the lists of general trading firms, but in regard to the electrical headings, we must remark that we should not like to think that the list of English manufacturers was a true representation of the extent to which electrical firms are pushing their goods in foreign parts. A number of firms of the highest standing at home, and whom we know to be exporters on a fairly large scale, are not in evidence among those termed by the editor of these guides "the principal British manufacturing exporters." The collection is by no means a complete guide to the principal exporters of electrical machinery and apparatus, and so cannot be considered fairly representative. The firms themselves may, of course, be partly to blame for this.

Porcelain Insulators.—We have received from Porzellanfabrik Hermsdorf-Klosterlausnitz, of Sachsen-Attenburgh, a catalogue showing sectional and other views of porcelain insulators for all kinds of purposes.

The "Petersen" Water-Tube Boiler.—The "Petersen" patent water-tube boiler for land and marine use is manufactured by Messrs. Clarke, Chapman & Co., Limited, of Gateshead-on-Tyne. Of recent years the tendency amongst engineers has been to increase the pressure of steam used in all types of boilers working both on land and sea (particularly the latter), as it has been demonstrated that the use of high pressure steam is more economical, especially in conjunction with compound and triple expansion engines. So long as pressures were moderate, the ordinary type of cylindrical marine boiler was found to answer the purpose; but it was felt that a time was approaching when this must give place to some other system, firstly, on the score of safety, and secondly, on account of the increased weight and thickness of the plates. Thus it has come about that the water-tube system has been perfected, and is enjoying increased favour generally. The "Petersen" boiler is a bold departure from anything which has preceded it, and its distinct peculiarity consists in the fitting together in one "nest" or "compound tube," of nine small tubes, whose ends are forced into the tube-plate of a wrought-iron box or "cup," which carries a means (either by flange or screw) of connecting it at each end with arrangements for supply and delivery of the water circulating within it. These compounds form the heating surface of the boiler, and are arranged either radially on each side of the furnace, having their upper ends fixed directly into the steam receiver, or in a sloping position beneath the receiver, and delivering their contents into a "rising header," common to two vertical sections which communicate with the receiver (see fig.). The advantages claimed for the "Petersen" boiler are:—1. Safety and Adaptability to High Pressure:—The larger portions of this boiler, such as the receiver, being relatively small, can be given such a factor of safety as to be beyond all chance of explosion, whilst the tubes of the compounds, which are but 1 inch external diameter, could not cause any damage in the unlikely event of one of them bursting, being but slightly larger than the glass tube of a water gauge. 2. Quick Raising of Steam:—The "Petersen" boiler in both its forms is stated to possess the power of being rapidly put under pressure, if required; thus, in a 400 H.P. boiler, steam can be raised to 150 lbs. from cold water in 20 minutes, thereby effecting a saving of both time and fuel, a consideration of no mean value in the case of warships, tugs, and other vessels, whose services may be required at very short notice, as well as in the case of steamers engaged in daily trips, where with ordinary boilers the expenditure of coal in lighting up and getting steam is very heavy in relation to the coal used on running the trip. 3. Efficiency and Economy:—In these respects, two six-hour trials were made respectively by Mr. Geo. Cawley, M.I.M.E., and by Mr. W. H.

Thomas, M.I.C.E., &c. In Mr. Cawley's trial, when burning about 30 lbs. of coal per square foot of grate per hour *with natural draught*, an evaporative efficiency was obtained of 9·35 lbs. to 1 of coal; in the other trial, with the slower combustion of 16 lbs., the efficiency rose to 11·25 lbs. to 1 of coal. 4. Freedom from Deposit on Heating Surfaces:—The circulation maintained within the tubes of the compounds constituting the heating surface (which is shown by the rapidity of raising steam), is said to be sufficient to sweep away all deposit formed by the water; this is forced to settle in the quietest part, viz., the lower water drum, where it is found as a mud and is easily blown out. 5. Dryness of Steam—Absence of Priming:—One of the most important features of this boiler is its power to produce dry steam without the slightest tendency to prime, even when the stop-valve is suddenly opened. In this connection it is believed to be far ahead of other water-tube boilers. 6. Compactness and Weight in Proportion to Power:—Although this boiler does not profess to be the lightest of the "Express" type of water-tube boilers, all of which contain a relatively small weight of water for the power developed, and on that account require some form of automatic feed apparatus, yet the "Petersen" boiler in either of its forms is claimed to be both lighter, and to occupy less space than several other types of water-tube boilers now in use. Because of the larger amount of water which it contains, it can be operated by any feed machinery of the usual kind without anything more than ordinary care and attention; at the same time it is equally suitable for use with automatic feed gear, if so preferred. 7. Ease of Erection, Transport and Repairs:—The "Petersen" boiler is put together entirely with ordinary bolted joints, which lend themselves to easy erection by ordinary intelligent labour, without any riveting or having to use an expander. It stands quite self-contained, forms the base of its own iron chimney, and can be erected on any firm ground without foundations. There is no external brickwork whatever—only the firebrick lining of the furnace, which is supplied with each boiler. In the case of re-boilering a ship, these boilers can be lowered into the stokehold without any cutting away of decks and fittings, such as is necessary with the cylindrical marine boiler. It is claimed that the cost of the "Petersen" boiler will compare favourably with that of the cylindrical marine type, especially when the highest pressures are demanded; it will also be able to compete in this respect with the favourite land boiler—the Lancashire, which, notwithstanding its general efficiency and simplicity of construction, has the serious disadvantage of having to be transported in one piece, and when on the site, it has to be built into an expensive brickwork setting, costing, say, one half as much as the boiler itself, not to say anything of its chimney (generally in brickwork), and foundations for same. Again, in up-country stations, it is difficult to repair, whereas in the case of the "Petersen" boiler, renewals can always be forwarded without serious delay or expense. Mr. Geo. Cawley, M.I.M.E., Mr. W. H. Thomas, M.I.C.E., &c., and Mr. Fortescue Flannery, J.P., M.P., have made very favourable reports on the boiler. Two of these boilers are used to supply steam for the whole of the machinery at the Newcastle Electrical Engineering Exhibition, which is now open. Each of the boilers there is evaporating easily 4,800 lbs. of water per hour. We illustrate the B type of boiler.



Trade with Japan.—The *Trade Journals Review* says that the United States Consul in a recent report calls attention to the fact that there is now established at Osaka a permanent museum for the exhibition of native and foreign productions, and he advises that all who are desirous of increasing their trade with Japan would do well to secure space for exhibits. He declares that there is a large and increasing demand for articles of European and American manufacture, particularly for all kinds of electrical appliances. It is pretty well known that Japan has extended the benefit of its patent laws to foreigners, otherwise it is almost certain that unprotected manufactures would be copied by the Japs without scruple.

ELECTRIC LIGHTING NOTES.

Ayr.—The Trustees of the Harbour have under consideration a proposal to light the harbour with electricity.

Birkenhead.—The Gas, Water, and Electric Lighting Committee have approved of a report by the electrical engineer (Mr. Shoolbred) recommending the extension of the electric lighting system to Oxton and Claughton. At present the centre of the town only is provided with electric lighting facilities. Application is to be made to the Local Government Board for power to borrow a sum of about £20,000 for the extension.

Bolton.—A Local Government Board inquiry was held on Wednesday regarding an application made by the Corporation for powers to borrow a further sum of £37,000 for electric lighting purposes.

Brighton.—The accounts of the Brighton Corporation Electricity Works for the past year, which are about to be presented to the Town Council, show a profit of £14,680 19s. 5d. on the year's working, so that with the balance brought forward from the last account the total stands at £15,830 19s. 5d. Of this, £4,519 18s. 3d. are absorbed by interest charges, and £4,311 1s. 2d. by sinking funds; £5,000 are carried to the next account, and £2,000 voted to the relief of the district rate. Of the year's income, £22,056 5s. 7d. was derived from electricity sales to private users, and £5,956 8s. 8d. from charges for public lighting.

Chester.—The Electric Lighting Committee have recommended the Council to authorise them to order additional plant for the generating station at a cost of £7,980, and to order further extensions of the electric lighting mains and street lighting, at a cost of £1,850. It was also recommended that the Council apply to the Local Government Board for sanction to borrow a further sum of £20,000 to cover extensions up to the present time, the additional plant required at the generating stations, and future extensions.

Colwyn Bay.—Dr. John Hopkinson has reported to the District Council that out of 10 schemes submitted to him for the electric lighting of Colwyn Bay, Messrs. Fawcus & Clirehugh's was the best, and Mr. Bennett's came next. Both firms are to appear before the Council and explain their schemes.

Coventry.—On Tuesday, the first annual report of the Electric Light Committee was presented to the Council. Alderman C. J. Hill, Chairman of the Committee, in proposing its adoption, said that in January, 1896, the loss was £6, and they supplied 1,824 8-C.P. lamps. In January, 1897, the profit was £93, and they supplied 5,662 lamps. In February, 1896, the loss was £16 18s. 2d. on 3,092 lamps; in February, 1897, the profit was £49 3s. 6d. on 5,930 lamps. In January, 1896, for 1,824 lamps the coal bill amounted to £18 13s; in January, 1897, for 5,662 lamps it was only £23 5s. Councillor West (Assoc.I.E.E.), vice-chairman of the Committee, said the supply was commenced in November, 1895, with only seven customers, and £20,000 capital had been spent. The customers, however, steadily increased until at the end of 1896 they had 72 with 5,662 lamps, and applications continued to be received. After discussion, in which the question of street lighting was proposed, the report was adopted.

Coventry.—The first annual report of the Electric Light Department shows a steady increase in the number of consumers. On January 1st, 1896, there were 31, with lamps connected equivalent to 1,834 of 8-C.P. On December 31st there were 72 consumers, with lamps connected equivalent to 5,662 of 8-C.P. Further connections are being made, and the extension of plant proceeded with. The accounts show a debit balance of £41 0s. 8d., which, considering the small amount of custom with which the year opened, the committee submit is satisfactory.

Darfield.—At a meeting held in the National School on 11th inst., it was agreed that it is desirable to institute a permanent memorial in connection with the Diamond Jubilee, such memorial to take the form of a public lighting installation, electricity being proposed.

Folkestone.—Mr. W. B. Hopkins, the promoter of the proposed Folkestone Electric Lighting Company, has submitted the names of the first five directors to the Corporation for approval:—Geo. Spurgen, Stephen Penfold, Daniel Baker, Charles J. Pursey, and W. B. Hopkins.

Fort William.—Major Cardew, electrical adviser to the Board of Trade, last week made an inspection of the whole of the works in connection with the supply of electricity to Fort William. He was accompanied by Mr. R. F. Yorke, electrical engineer to the Fort William Electric Light Company. Major Cardew expressed himself thoroughly satisfied with all the arrangements that had been made.

London.—The Metropolitan Electric Supply Company, Limited, are to be allowed to appear in opposition to the London (Clare Market, Strand) Provisional Order Bill.

Mill Lighting.—The Platinotype and Electric Lighting Company are installing a service of electric lighting throughout Messrs. Joynson's large paper mills at St. Mary Cray.

Newcastle (Australia).—We understand that the Newcastle Municipal Council has, in committee, resolved to recommend the adoption by the Council of the scheme formulated by Mr. Elwell, electrical engineer, for the extension of the municipal electric lighting system, and the abating of the nuisance arising from smoke and noise at the works in Sydney Street.

Newport.—The report of the Electricity Committee which had been to various towns to collect information to guide them as to future extensions of the electricity works, has been submitted to the Newport County Council. It was recommended and agreed that the extension take place on the following lines:—Two slow-speed compound condensing horizontal engines with fly-wheel alternators, each of 300 kilowatt capacity, the alternators of the stationary armature type made to run with the least possible noise, and the condensers to be combination with the engines, Lancashire boilers to be used; the switchboard, extended and improved, to be of the Lowrie-Hall pattern, mounted on iron or steel framing, and that Mr. Hammond be reappointed consulting engineer, subject to satisfactory terms being arranged. The terms which the committee found Mr. Hammond would require were 5 per cent. on the outlay, which was estimated at £30,000, in addition to the sums already spent.

We understand that the rates are to be drawn upon to the extent of £1,610 this year, to make good the deficit in the electric lighting accounts.

Paisley.—Tenders for supplying and erecting plant for the electricity works have been referred to Mr. Teague, the electrical engineer, to report upon. The Secretary for Scotland, in sanctioning a £35,000 loan, recommended the Council to set aside a sinking fund of not less than £1,000 per annum.

Plymouth.—Mr. John Harris, electrical engineer of Stonehouse, has just made extensive additions to the electrical plant for Messrs. Bickle & Co., Limited, necessitated by the extension of their engineering works, situated in the Great Western Docks, Plymouth. The electric lighting of these works is carried out on the multiple series system of arc lighting throughout the turnery, erecting shops, and moulding foundry. The generating plant is a steam-driven Taunton dynamo.

Southampton.—An application from the Surveyor of the Board of Works for the supply of electric light to the Ordnance Office has been referred to Mr. Manville to report upon. The electrical engineer's report shows that the number of units sold during January was 17,550, an increase of 2,270 as compared with last year.

Taunton.—The Town Council has decided to introduce a system of free wiring and the supply of electricity by penny-in-the-slot meters.

Walsall.—The Electric Lighting Committee report that the number of consumers on February 28th was 79, the total units registered on the meters being 8,068 for the month. The wages paid were £40, and the coal consumed was valued at £23 10s.

Yarmouth.—Additional condensing plant is required for the electricity works at a cost of £1,200. Mr. Preece is to obtain tenders for the work. The price per unit of current for motive power purposes is to be reduced to 3½d. The accounts for February show that the earnings amounted to £135 beyond the cost of production.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Belfast.—The scheme of the Belfast Tramways Company for extending their tramways was before the County Down Grand Jury on 11th inst. and consent was given.

Birmingham and District.—We understand from a Birmingham paper that the Birmingham, Wolverhampton, and District Tramways Bill will not proceed any further, as when it came before the Examiner in the House of Commons on 12th inst., the necessary consent of the Wolverhamption Corporation was not proved.

It is stated that the Company does not intend to proceed further with their Bill during the present session.

The Dudley Corporation has decided, after consultation with the officials of the Company promoting the tramway scheme, to withhold assent to the Bill now before Parliament.

Cairo.—The recently established electrical tramways in Cairo are a great success, and notwithstanding the very low rates, which are something less than 1d. for a distance of 3 miles, they are being worked at a profit. The electric lighting is also being extended, and on account of the numerous overhead wires which are spreading in all directions, the Government propose to issue rules which will have to be adhered to in all future installations. Mr. Killingworth Hedges, M.I.C.E., who has recently visited Cairo, has been instructed to prepare a specification for the use of the Public Works Department, who will most probably appoint an inspector to see that the regulations advised by Mr. Hedges are carried out.

Llanfair to Beaumaris.—The Beaumaris Town Council had before it the other day a letter from Mr. Theo. Rowlands, who represented a Syndicate, asking for the Council's consent to the construction of an electric light railway from Llanfair P.G. to Beaumaris. A resolution was passed giving a general assent provided full particulars as to gauge, speed, &c., are furnished.

Liverpool.—We understand that the Corporation is to negotiate with the Liverpool Tramways Company for the purchase of its lines, thus removing the necessity for the present Corporation Bill.

Norwich.—The Norwich Electric Tramways Bill came before the Standing Orders Committee in the House of Lords last week, the Earl of Morley presiding. The examiners had reported that the Standing Orders had not been complied with. Mr. Kennedy, Parliamentary agent for the promoters, now explained that the consent of the Corporation had been obtained to the proposals contained in the Bill, and a petition from the inhabitants had been presented in favour of dispensing with the Standing Orders. Lord Morley said the non-compliance appeared to be very small and trivial, and he should therefore allow the Bill to proceed in the usual course, the Standing Orders being dispensed with.

Southampton.—The Electric Lighting Committee has reported as to the proposed supply of electric power to the Tramways Company and recommends the Council to supply electric current to the Tramways Company, in the event of the purchase of the undertaking by the Corporation, and the leasing thereof to the Tramways Company, at the following charges, viz.:—For the first 50,000 units used, 3d. per unit; for the next 50,000 units used, 2½d. per unit; for the remainder used, 2d. per unit.

TELEGRAPH AND TELEPHONE NOTES.

Cable Communication Tariffs.—In the Commons, on 15th inst., Mr. Hanbury, replying to Mr. Henniker Heaton, said:—The Postmaster-General has, from time to time, received representations on the subject of the charge to India, and has endeavoured to bring about a reduction, but so far without success. The charge to Japan by the cheapest route is 8s., not 10s. 8d., and to British Guiana not 12s. 11d., but 10s. He is not aware of any general feeling of discontent, and, as he does not think that any useful purpose would be served by an inquiry into the questions raised by the hon. member, he is not prepared to recommend the appointment of a Royal Commission. The Postmaster-General has no information as to the amount paid for telegrams by merchants engaged in the Anglo-Australian trade, and it is not within his province to state what the expenditure of the Government is on telegrams to and from places abroad. The Postmaster-General has not had before him any calculations as to the cost of constructing and maintaining a set of cables to take the place of those which are already in existence, and he has no reason to suppose that cable communication to all parts of the empire could be given for a tenth of the present rates. It would seem to be entirely contrary to sound policy for the State to attempt to acquire all the existing cables. They are necessarily landed at a great many points in foreign territory, and it is not to be supposed that foreign countries would acquiesce in the working of the cables by the British Government, although they are quite ready to come to terms with British companies. At the Telegraph Conference in Budapest arrangements were made for very considerable reductions in the charges to various parts of the world. Some of these reductions are already in force, and the rest will be brought into operation on July 1st next. I may add that these arrangements could not have been made without the cordial co-operation of the British cable companies.

We commend the Postmaster-General's attention to the advances being made by an adjacent country in the practical acquisition of cable communications by means of contracts, which provide a control amounting to a complete ownership. That Government also collects, and hands over to their own enterprises, unrouted traffic. There is no doubt, and we believe the Post Office concur, so far, that Her Majesty's Government should have control, by ownership, of cables landing on British soil, and it would be a profitable undertaking. The first small plunge was made by them when the Channel cables were acquired up to half way across the Channel. There is no doubt that a mass of evidence must be in the Post Office and other Government Departments of the general discontent as to telegraph charges to the East and West Indies. Such evidence is on record in the past issues of our Journal, and there seems to be no doubt that that discontent has been expressed without avail, especially in the latter colonies, for a great number of years, and it should receive more attention than has been given to it, as the Postmaster-General's reply given by Mr. Hanbury is extremely unsatisfactory.

Coast Communication.—An Edinburgh paper understands that the Royal Commission on Lighthouse Communication have asked Mr. C. A. Stevenson, C.E., to give them advice on the question of communicating by induction.

French Cable Enterprise.—The ss. *Portena*, recently purchased by the French Cable Company from the Chargeurs Reunis Cie Française de Navigation, is an iron screw steamer of 2,311 tons. She arrived in the Albert Dock on Friday last with a considerable length of cable on board. After the completion of the fitting of her gear, which is being carried out by Messrs. Johnson & Phillips, she will proceed, some time during the coming week, on her voyage. We understand the *Portena* will, on her arrival in the West Indies, make certain repairs and extensions of the French telegraph system in those waters. The *Portena* is now the third cable ship flying the French flag.

The Telephone Service.—Replying to Mr. Provand in the House of Commons on 12th inst., Mr. Hanbury stated that he could not grant the returns asking for particulars relating to the construction, maintenance, and earnings of the telephone exchanges carried on by the Post Office.

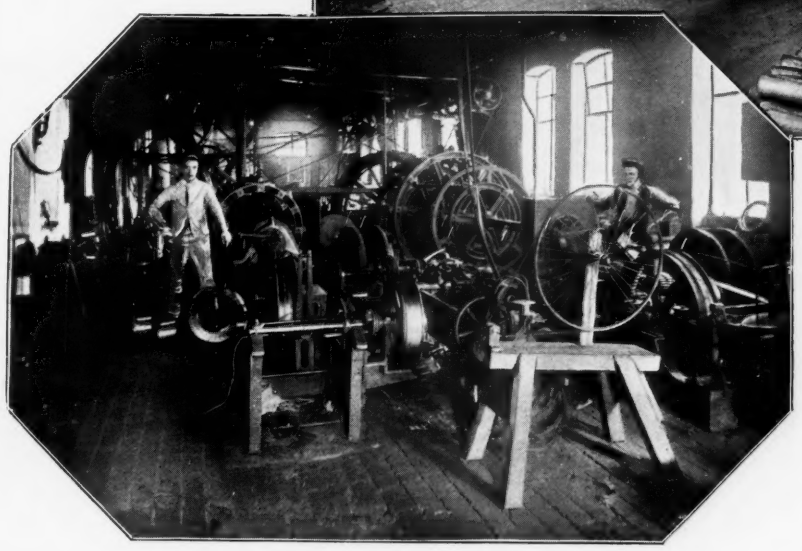
(*Telegraph Notes continued on page* 393.)

THE COPPER WORKS OF MESSRS. BOLTON AND SONS.

There is no material in which the electrical engineer is more directly concerned than copper, and we feel that an account of works solely devoted to the refining and production of this important metal will be of considerable interest to the readers of this Journal. The copper industry, it need hardly be said, was one of some magnitude when electrical phenomena had scarcely appeared in the laboratory.

The history, or we might say, an account of the rise and fall of copper, would make interesting reading. It would be unnecessary for such a history to be comprehensive enough to include the work of Alexander the Coppersmith, much less the extensive use made of copper by Cyrus, King of Persia. One must admit, and reluctantly, perhaps, that the present price of copper is of far more concern to the producers and consumers than the fact that Syrians and Phœnicians were large users of the metal. Though even if one were not a consumer of copper, one could not fail to be interested in the extraordinary fluctuations in the prices that have taken place during the past 50 years. In 1840 the price of unwrought copper was as high as £86 per ton, but in 1857 it reached the extraordinarily high sum of £118. Since that time, however, the price of copper has steadily declined, save for an occasional artificial inflation caused by speculators, until at the present moment it is something less than £51 per ton, notwithstanding the growing demands of the electrical industry. This low price arises mainly from the very considerable imports of copper from America and other countries, and it is obvious that if these imports from some reason or other were to suffer diminution, there would follow an increase in the price. It might not be that an increase would be of greater permanency than a few months, because even if present prices were slightly enhanced, it would enable those mines to increase their output which, at the prevailing prices of G. M. B's., are scarcely worth working. Some time would elapse, however, before an increase of copper could be put on the market, hence we may fully expect in the next few months a rise in the price per ton of copper, especially as the visible stocks of copper are lower than they have been for over 20 years. It is not likely that the demand for copper in the electrical industry will suffer any immediate diminution, for the fact that public electric lighting has been proved to be a conspicuous success during the past 12 months is not only causing existing works to extend their mains, but towns that have previously refused to adopt a public system of electric lighting are now inclined to start and operate public works. Moreover, we may expect great developments in two directions: in street lighting and in tramway work, and it need hardly be said that these operations will necessitate great quantities of copper. Electrical engineers have, or ought to have, a clear appreciation of the extent to which copper predominates in their work, the generation, the distribution, and to a great extent, the measurement of electricity, call for large quantities of copper, and when we say that one town, in carrying out some ordinary extensions, needs 100 tons of copper—equivalent to over £6,000, it is sufficient to show that the aggregate requirements of the electrical industry are very great.

Wire Rolling at Oakamoor.



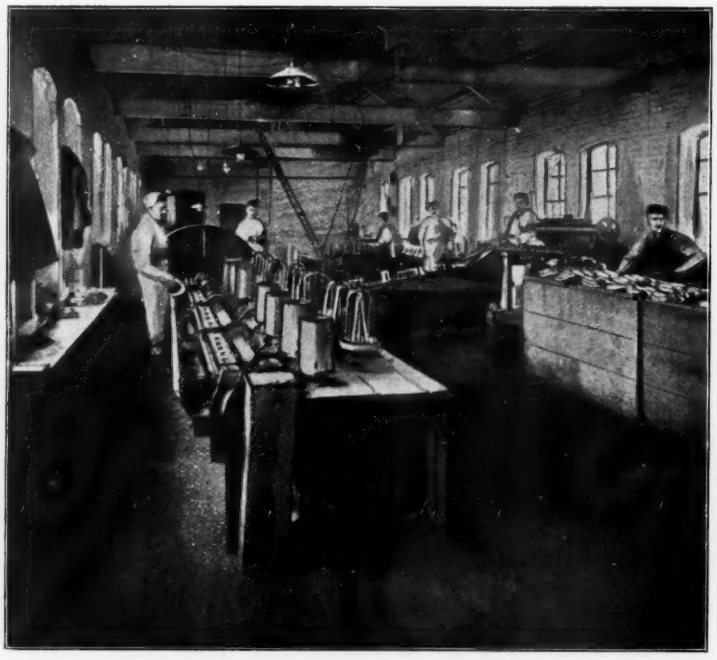
Wire Stranding at Oakamoor.

The copper industry may be said to have received its first impetus in this country in 1761, when copper sheathing was first employed on a man-of-war. It was some 22 years later, in 1783, that the now widely known firm of Thomas Bolton & Sons was established in Birmingham, and later, about 1850, when copper for electrical purposes began to be more in demand, they were led to acquire the works at Oakamoor, which had previously been occupied mainly with brass, especially the fine qualities which were used for decorative purposes, such as in churches. It is a curious fact, that the old calamine brass, made from zinc ore, as the name implies, had the property of keeping its colour better than modern brass made by mixing copper and zinc in the metallic state. A casual observer visiting Oakamoor for the first time would be, perhaps, puzzled to account for the presence of copper works in a neighbourhood which is chiefly remarkable for the beauty of its scenery; indeed, when we say that Oakamoor lies in the Churnet Valley, and is within a stone's throw of the famous Alton Towers, it is unnecessary to say more about the picturesqueness of the locality. To explain the presence of the works, however, it is necessary to mention that their founder selected Oakamoor not so much on account of the rich beauty of the scenery, but for the more utilitarian reason that copper existed on one side of the hill, and on the other side coal of a first rate quality was to be

obtained, while in the valley between, a considerable water power was available. The copper mine in the district was long ago exhausted, but before that period arrived the works had been increased to such an extent that it would have been impossible to transfer the operations elsewhere, although the reason for settling in the neighbourhood had long since vanished.

The extensive copper works of Messrs. Bolton is now carried on at practically five places, Oakamoor, Froghall, Widnes, St. Helens, and Birmingham, the work carried on at the different places being for the most part distinct. The Widnes works, for instance, are mainly devoted to the production of the raw material; that is, the copper ore is reduced to a workable condition; and there is also a considerable amount of electro-deposition carried on at Widnes, which will be referred to in greater detail. The branch of the business carried on at Sutton Mills, St. Helen's, is the making of calico printers' rollers and copper cylinders, which are made by special hydraulic machinery; in addition, the manufacture of copper sheets and fire-box plates is carried on in an extensive way. These mills, it may be mentioned, were acquired some two or three years ago, having been previously worked by Messrs. Newton, Keates & Co.

The Birmingham factory is mainly occupied with the making of brass wire and rolled metal in addition to doing a large trade in dial copper for the watch trade. Perhaps the best known production from these works is the special standard wire, which is used so largely in paper making. Froghall may be said to be given up entirely to the electro-deposition of copper, while Oakamoor, which is within three miles of these latter works, is the centre of the wire-making branch of the business, though the manufacture of copper tubes is a very important department. With these preliminary remarks we will now consider the various processes in some detail.



Fine Wire Drawing at Oakamoor.

Commencing with the production and working of copper in its earliest stages, one must start with the Widnes works, and as an interesting fact in the growth of Messrs. Boltons' business, it is worth mentioning that this factory was taken over in 1881, and at this time two furnaces did all the smelting that was required; in other words, the output per month was 150 tons, while the present power of production is over 1,000 tons per month. It was originally designed that these works should supply raw material for the manufacture of high conductivity work at Oakamoor, but this sphere of operations has been greatly extended, and in addition to supplying raw material for their own use, they supply a good deal to other wire manufacturers. At the Widnes works, which, by the way, cover some four acres of ground, are received what are known as "Argentiferous pigs" and ores from other parts of the world; these are put into the furnaces and melted down in the ordinary way, the molten metal in some cases being run into flat moulds. These flat pieces are then used as anodes in the electro-deposition process, from which the high conductivity copper is obtained. It is, of course, well known that high conductivity copper approaching or beyond 100 per cent. of Matthiessen's standard for pure copper is obtained only by electrolytic means, though we shall have more to say on this particular process when we come to discuss the Froghall works; but we may mention here that there is some 300 tons per month of copper deposition done at Widnes, and one of the illustrations gives an excellent idea of the arrangement of the depositing plant, where many tons of copper are deposited in the course of a month. It will be seen that the electrolytic tanks are arranged on a series of levels, so that the liquid may run from the topmost tank to the lower ones, the solution being kept by these means in a constant state of change. With such an extensive array of depositing tanks, the electrical generating plant necessary is of considerable dimensions, and a further illustration shows the interior of the dynamo and engine house. There are four four-pole continuous current machines, of the Elwell-Parker type, made by the Electric Construction Corporation, which are driven by two Galloway engines, belt driving being employed. It may be observed that these dynamos have been running for some years on almost continuous duty, and the troubles that have arisen have been of quite a minor character, although the machines are usually under a condition of overload. The dynamos are mainly used for deposition work, the lighting of the works being comparatively unimportant.

The furnaces at Widnes are by no means confined to the smelting of copper for deposition purposes, locomotive plates and bolts of every description being manufactured on a large scale. It need hardly be said that great purity and the capacity to withstand high tensile strain is of the utmost importance in copper that is used for other than electrical purposes. The use to which copper is applied in locomotive work, for instance, tests the metal very severely, and a considerable amount of the output of Messrs. Bolton finds its way on to the various railways in this country as well as abroad. One of the illustrations of the furnaces at Widnes shows the process of lading ingot copper. The plant at Widnes is on an extensive scale and capable of dealing with sugar refining pans and locomotive and other plates up to 12 feet wide. The illustrations showing the steam hammers and rolling mills give a fair idea of the magnitude of some of the operations. Copper sheathing, ingot copper rods, and sheets of all kinds are largely produced at Widnes.

It is obvious that to arrive at any degree of perfection in the working and refining of copper necessitates some careful methods of testing and analysing, and at Widnes a large staff of metallurgical chemists is employed to analyse the various ores and materials for the manufacture of copper. Samples of ores are continually arriving from all parts of the world, Japan, Australia, and America furnishing an abundance of new specimens. We have already said that the Widnes works are chiefly employed in preparing raw material, which is afterwards worked up into high conductivity copper at Froghall. For this purpose ingots and vast quantities of anodes of copper are sent from one place to the other.

Froghall is the real home of electrically-deposited copper, and for this operation engines and generating plant

on a large scale are provided, indeed, it will be observed from the illustrations, that there are many central electric light stations whose machinery is a good deal smaller than the Froghall plant. There are four sets of triple expansion engines working at 150 lbs. pressure; they work condensing, and are provided with Corliss valves on the high pressure cylinders and slide valves on the other cylinders. Each engine drives two dynamos by ropes, and the rope drive is of a peculiar character, the engines being on one floor, while the dynamos are on a floor below, this special arrangement being necessary to obtain the length of drive. The dynamo machines are of similar type to those at Widnes, namely, Elwell-Parker, and have been in continuous service for some years. Their nominal capacity is 1,500 amperes at 50 volts, though it is not uncommon for them to be worked at much higher rate than this. If all these machines are employed on the deposition of copper they would do about 700 tons per month, though, at the present time, half the machines are working on copper ore or nickel and other things.

It is hardly necessary to say that the electro-deposition or the refining of copper by electrolytic means has been considerably developed in Europe during the past 20 years; and probably the earliest Wilde and Gramme dynamo machines were used for this purpose. We have already referred to the fact that this method has been alone responsible for the great improvement that has been effected in the purity of copper. Not very many years ago a conductivity of 96 per cent of Matthiessen's standard was looked upon as something exceedingly good, and when the copper refiners reached 98 per cent., it was thought a figure had been obtained which would never be beaten, and, although this purity is surpassed nowadays, 100 per cent. being always guaranteed by Messrs. Bolton, 98 per cent. copper became the final standard of excellence in the minds of some electrical engineers, and many steadily refuse to adopt the 101 and 102 per cent. which are now commonly obtained.

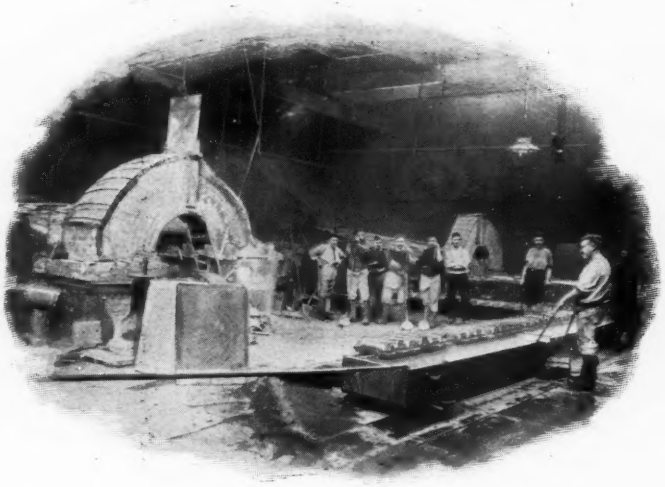
Although there is always an air of mystery about the production of electrolytic copper, engendered, no doubt, by the silent nature of the work, there is nothing very complicated in the process. The chief feature is that anodes of impure copper are suspended in a solution of copper sulphate, and thin plates of pure copper are used as the cathodes. The action is that the pure copper is precipitated on the cathodes, while the impurities, among which gold and silver prominently figure, fall to the bottom of the vat. The chief difference in the methods of the copper refiners lies in the use of series or parallel methods, and, perhaps, the subject has never been better summed up than by Mr. James Swinburne, who, in his recent Cantor lectures, said:—

"The main difference between two classes of copper refining processes consists in the series or parallel coupling of the plates. From a purely electrical point of view, this looks like a distinction without a difference, but there is more in it than appears at first sight. It makes little difference in the energy used per ton of copper refined, the only source of divergence being the numerous contacts in the parallel system. When a vat only takes a fraction of a volt, a large proportion of the power may be wasted on imperfect contacts.

"The series arrangement, however, saves a good deal of money in the leads, and greatly simplifies the connections. It is often supposed to have some magic efficacy in giving a greater output of copper for a given power, but that is absurd. Its great advantage really lies in its needing less copper in the vats for a given output. This may seem a small matter; but if prices are worked out, it may mean a very important saving. Take an example. Suppose copper is deposited at, say, 5 amperes per square foot, and suppose the anodes are cast, say, three-quarters of an inch thick, and are eaten off both sides. Roughly, the anodes will take two months to be deposited on the cathodes. Take the case of a refinery dealing with 1,000 tons of

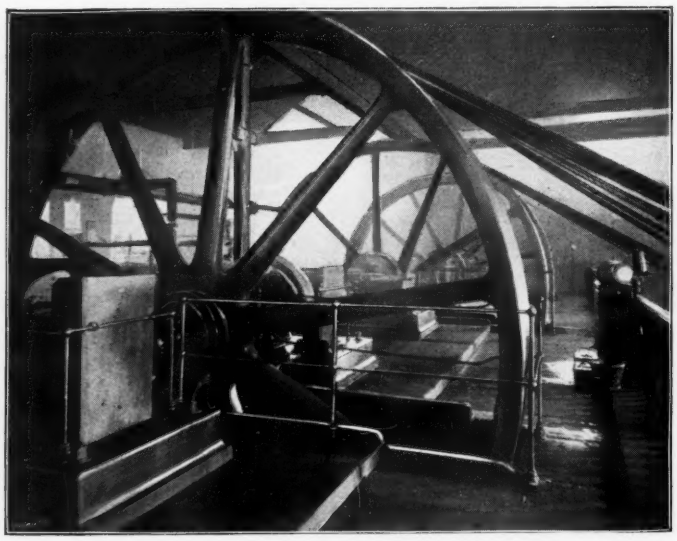
Electro-Depositing of Copper at Widnes.

copper per month. This means that 2,000 tons are in the vats. As a matter of fact there will be a little more, but we can take 2,000 tons as a good round figure. The value of this copper at £60 per ton is £120,000. Now, the question is, what value is capital to the owners of the refinery? They might, perhaps, be able to borrow money, partly on the security of the copper at a low interest; but it is more likely that money is worth 6 per cent to them, or in other words that their works give 6 per cent. on the capital sunk, and would give at least that interest on any further money sunk safely in enlargement. The interest on the copper in the vats is thus £7,200 a year, or £600 a month. As the output is 1,000 tons a month, this means that the price of refining copper is increased no less than 12s. a ton for interest on the metal in the vats. It is then of great importance to keep down the amount of copper going through the works, that is to say, to make it go through quicker. A little can be done by removing the cathodes when they are $\frac{3}{8}$ths of an inch thick, instead of $\frac{3}{4}$, and putting in new ones. This reduces the 12s., not to 6s., but to something above 9s., how much above 9s. depends on the cost of the initial cathodes."



A Refining Shed at Widnes, Ladling Ingot Copper.

The series method is used at Froghall, the series of vats varying from 60 to 70 tanks. Each tank contains 10 anodes and nine cathodes, the amount of deposited surface in each tank being 180 square feet. The vats are about 3 feet 6 inches deep, 4 feet in length, and 2 feet 6 inches in breadth, and are lined with lead. The conductors take the form of a flat strip, which is laid along the edges of the vats. The anodes are provided with arms which rest on the sides of the vats, while the cathodes are suspended on copper bars at Widnes and hollow copper rods at Froghall.



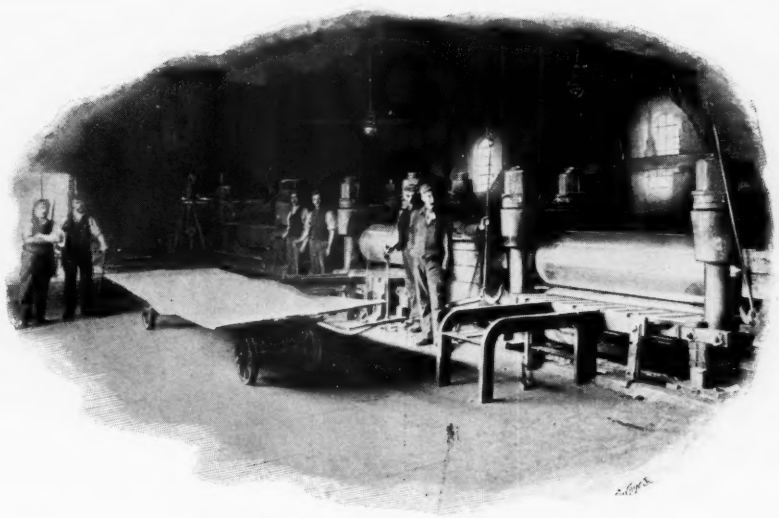
Engines at Froghall.

It will be remembered that the late Sir William Siemens gave it as a theoretical figure that "the effect of 1 horse-power expended in driving a dynamo machine of suitable construction, is to precipitate 1,120 lbs. of copper per 24 hours, equivalent to an expenditure of 72 lbs. of coal, taking a consumption of 3 lbs. of coal per horse-power hour." We are not in a position to give the exact deposition per horse-power hour obtained at Messrs. Bolton's works, but there is little doubt that the difference between the practical and theoretical figure is not so widely apart.

The electro-deposited copper is cast down to a suitable size, and we were much interested on the occasion of our visit in the rapid way with which the men deal with the molten metal. Billets were being cast, the molten copper being poured from hand ladles into open moulds, scarcely a few seconds elapse before the mould is conveyed on to a plate which tilts sufficiently to allow the red hot billet to slip out two or three inches; it is then seized by long pincers and drawn away to a place where a constant stream of water plays on the hot metal. Following the progress of the billets a little further, they are conveyed down to Oakamoor, and if destined for wire, next appear in the rolling mills. Here they are made red hot and passed through a series of mills until the billet, which is about $4\frac{1}{2}$ inches thick, is reduced to $\frac{1}{4}$ inch wire. Scarcely a minute elapses before the stumpy billet becomes a squirming wire of great length; as it comes through the final machine it is seized by an agile youth and carried to a winding apparatus which speedily converts it into a coil. An illustration shows this characteristic operation. The rolling mills are driven by a horizontal compound engine, and it is needless to say that the demand on the engine is of the most varied character. It is interesting to mention as showing the general accuracy of the drawing operation that the makers are able to guarantee that the variation in a coil of wire a mile in length shall not be greater than $\frac{1}{2}$ mil. All the ordinary cable wire is annealed after it is drawn.

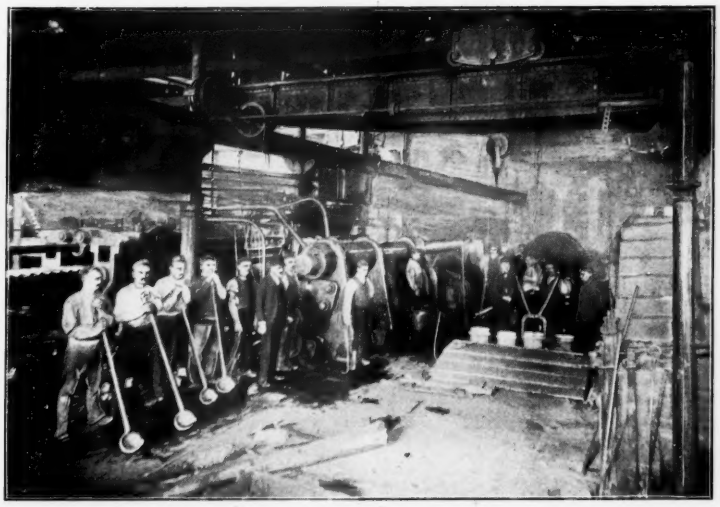
Although overhead wire for electric railways and tramways is, comparatively speaking, a new feature in this country, Messrs. Bolton have supplied a good deal of that already in existence in the United Kingdom, and there is little doubt that they will be able to adapt themselves to meeting the larger demand that must necessarily arise. Some interesting experiments have been carried out at Oakamoor on the jointing of wires for overhead purposes, especially for electric tramways on what is known as the "trolley" system, and we shall not be surprised to find that the outcome of these experiments will result in wires being made of greater length than has been hitherto achieved, without any joints whatever. Tests on the present method of jointing employed at Oakamoor have shown that it is absolutely mechanical and reliable. The overhead wire is drawn hard, that is, drawn to give 30 tons on the square inch tensile strength. It is, perhaps, supererogatory to mention the renown which Oakamoor wire has achieved with regard to strength, but we shall have occasion to refer to this attribute before we conclude these remarks.

The manufacture of the fine wire has been developed to a great extent, the smallest wire being drawn to 1 mil. or a third the thickness of an ordinary hair. This wire is drawn through diamonds on a patent continuous machine. The fine wire after being drawn is annealed, and in order that it may not become oxidised, it is annealed in a closed pot, and consequently comes out as bright as it went in. The wire is usually tinned when it is to be insulated with vulcanised rubber, the tin for this purpose being electro-deposited at Froghall to ensure purity, as impure tin is liable to being attacked by the sulphur used in the process of vulcanising. There is a wire drawing room at Oakamoor, which is distinctly interesting in a historical sense, for here the wire for the very earliest submarine cable—the 1849 Dover-Calais—was made, and afterwards a large portion of the early Atlantic cables.



Rolling Mills at Widnes.

The making of commutator bars forms a large department of the works, and these are drawn through dies. To show the multiplicity of sizes of commutator sections, it is only necessary to mention that Oakamoor has registered 1,000 different dies, and they are constantly adding to these; they are usually drawn hard. Bare copper mains are produced in large quantities, and are usually drawn in 600 feet lengths; in addition are all kinds of forgings for alternators and other purposes.



Tube Shell Shop at Oakamoor.

The production of copper tubes for all kinds of purposes is very considerable, and in this work a special hydraulic machine forms an essential feature; this machine, which has a pressure of 2,400 tons on the ram, punches out of the solid, cylinders from about 4 inches $\times$ 1$\frac{1}{2}$ inch up to 12 inches $\times$ 1 inch thick; these are afterwards drawn down on a mandril to any diameter required, while for tubes of small diameter such as are used in the boilers of locomotive engines, a billet of about 8 inches diameter is placed in the machine and literally "squirted" out in a few seconds into a tube of about 3 inches diameter by $\frac{3}{8}$ thick ready for cold drawing to the dimensions required. This hydraulic process while giving excellent results as regards quality, has had the effect of cheapening the production of seamless copper tubes to such an extent, that Messrs. Bolton are actively engaged in increasing their cold drawing plant with a view to turning out very large quantities of finished tubes in the future. The making of brass and aluminium tubes is also carried out on a large scale.

The illustrations that have not been already mentioned, are the fine wire mill, the stranding shop, and the tube-shell making shop. It should be mentioned that our illustrations give only a faint idea of the multiplicity of operations that are being conducted in the different shops. Exigencies of space, and the fact that it was impossible to make photographs, prevent them finding a place in this description.

The testing of wire for all purposes is most minute and searching, and a constant series of tests are being made on wire for use on the Post Office Telegraph System. We will quote the first four clauses of the Post Office Specification; but it is an interesting fact that this specification was originally drawn up from tests carried out on Oakamoor wire.

1. The wire shall be drawn in continuous pieces of the respective weights and diameters given in the table, and every piece may be gauged for diameter in one or more places.

2. The wire shall be perfectly cylindrical, uniform in quality, pliable, free from scale, inequalities, flaws, splits, and other defects, and shall be subject to the tests hereinafter provided for.

3. Every piece may be tested for ductility and tensile strength, and 5 per cent. of the entire number of pieces may be cut and tested in any part. Pieces cut for this purpose shall not be brazed or otherwise jointed together, but each length shall be bound up into a separate coil.

4. The wire shall be capable of being wrapped in six turns round wire of its own diameter, unwrapped, and again wrapped in six turns round wire of its own diameter in the same direction as the first wrapping, without breaking; and shall be also capable of bearing the number of twists set down in the table without breaking. The twist-test will be made as follows:—The wire will be gripped by two vices, one of which will be made to revolve at a speed not exceeding one revolution per second. The twists thus given to the wire will be reckoned by means of an ink mark which forms a spiral on the wire during torsion, the full number of twists to be visible between the vices.

It is not necessary to reproduce the table, but to show the ease with which the wire fulfils the conditions, we may mention that we witnessed the twist test on a piece, and while the

Post Office stipulated for 25 twists, it was not until the wire had been twisted over 60 times, that it broke.

We have by no means attempted a complete description of Messrs. Bolton & Sons works, we have only endeavoured to deal, and in a perfunctory manner, with that branch of copper which had direct reference to the electrical industry.

We have to thank the various partners in Messrs. Bolton and Sons for giving us information, and permitting us to freely inspect the various branches of copper manufacture; we have also to thank Mr. W. Lee Matthews, of 90, Cannon Street, London, the agent of the company, for assistance in compiling this account.

THE FRANZ-JOSEPH ELECTRIC UNDERGROUND RAILWAY AT BUDAPESTH.

This railway which has been designed and carried out by Messrs. Siemens & Halske, is the first underground city railway which has been constructed on the continent. It was commenced on August 13th, 1894, and has been so rapidly pushed forward that it was ready for being opened on May 2nd, 1896. We referred to it in our issue of May 8th, 1896.

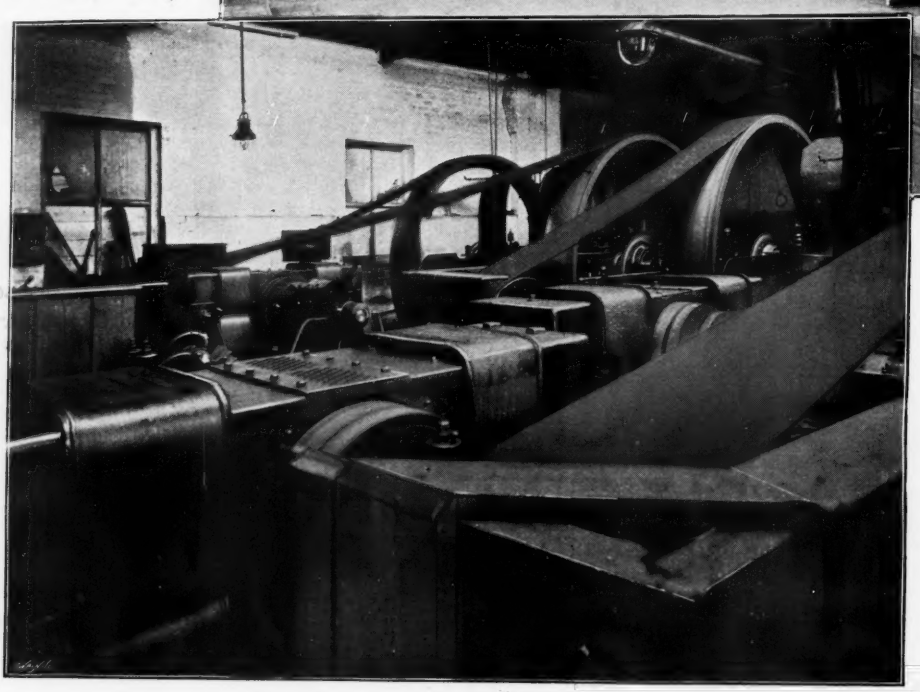
This underground railway is not a tunnel, like the City railway in London, but may be called a sub-pavement railway, since it lies directly under the paving of the street. It follows the course of the streets, and has two tracks of normal gauge, throughout its whole length. There are 11 stopping places, at which places only passengers are taken on and put off; being, in this respect, more like the city railway than the tramway.

The 3,700 m. length of the line begins in the inner city at the Gisellaplatz, and passes under several streets as a sub-pavement railway till the Stadtwäldchen is reached, when it emerges to the surface.

The tunnel is divided into two sections by a row of pillars running along the centre, between the two tracks. The floor of the tunnel consists of two arches meeting in the central ridge which supports the pillars. The two perpendicular side walls are 1 m. thick, except at the top where they thin off to ·65 m. The tunnel has a clear width of only 6 m., and a clear height of only 2·75 m. The floor and side walks are made entirely of concrete. The roof consists of rolled iron beams of 300, 320, 350 mm. in depth, and concrete covered plates of 1 m. span covering the spaces between the beams. To protect the roof of the tunnel from the infiltration of moisture, it is covered with asphalted felt.

The stations, like those of the underground railway in London, have stairs leading to the street, but in this case there are not more than 19 to 24 steps from the platform to the street. The walls of the stations are covered with white majolica ware.

Steam Hammers at Widnes.



Electrical Generating Plant at Widnes.

The machine installation consists of two condensing steam engines. Each engine drives directly an inside pole dynamo of the Siemens-Halske J 110 pattern. Each dynamo can supply, at 300 volts, a permanent current of 1,100 amperes, which may be temporarily raised to 1,400 amperes. Only one of the machine groups is at work at a time. Insulated feed and return conductors are used throughout, which are supported on the roof in the tunnels, and on wires stretched between pillars in the open parts of the line.

The cars are of the bogie type, an electromotor being fixed on each bogie to drive one axis. Each car contains 28 seats and 14 standing places, and its breadth is 2·35 m.

In six months from May to the end of October, 2,702,000 passengers were carried, and 453,000 car km. were run. Even after the end of the millennium exhibition at Budapesth the traffic on the underground railway was remarkably brisk. From the beginning of November to the middle of January, 1897, *i.e.*, 2½ months, 572,000 passengers were carried, and 172,200 car km. were run.

THE DEVELOPMENT OF THE RUDDER MOTOR.

We have on various occasions commented on the use that was being made of electric motors for propelling boats, and we have particularly referred to what is known as the rudder motor. It is obvious at the first glance that the main essential in an appliance of this description is extreme lightness, coupled with a moderate electrical efficiency. Even the makers do not claim that the vessels to which such mechanism can be applied are more than of moderate size, and it is clear that the use of a rudder motor has distinct limitations. But within these limitations there is abundance of scope for so ingenious a contrivance. The special feature of the rudder motor is that it may be applied to skiffs, punts, dinghies, without in any way altering their construction, and this is a feature that should appeal to all classes of the great boating public. Even a rowing man will appreciate it, while it may even tend to eliminate that great scourge—the man who can't row. It permits to the fullest extent of that delicious idling which is the very essence of up-river life; and it will enable one to cover a distance within a certain time that has been hitherto possible of accomplishment by only steam or electric launches.

Electrical Generating Plant at Froghall.

The rudder motor is by no means new to the river; indeed, it has been to some extent in use for two or three seasons, but the experience that has been gradually accumulated of the performance of this type of propeller has enabled the inventors or promoters to carry out so many improvements that lead one to think that they have arrived at a really practical appliance.

We have recently had an opportunity of examining the latest type of rudder motor made by Messrs. New & Mayne, and it must be admitted that it is vastly superior to the previous type; it is not so much that the main features of the invention have been altered, but rather that the construction and arrangement of the various parts have been improved.

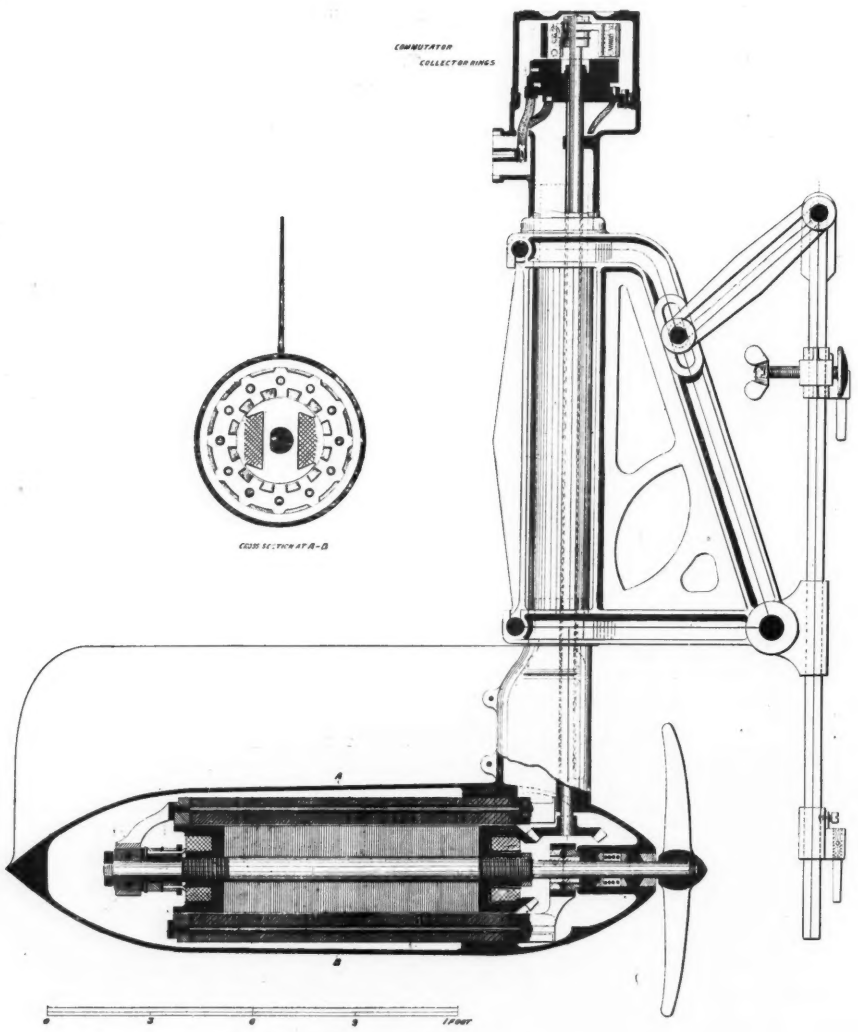
The rudder motor consists of an electric motor specially constructed in the shape of a small torpedo; it was this peculiarity that filled a good sized policeman with alarm when he viewed a rudder motor at Westminster Bridge. The necessary conductors are conveyed from the yoke or tiller bar through the supporting tube, which forms part of its construction. The rudder is fitted with an adjustable frame which enables it to be attached to any boat, but the yoke, or tiller bar, and adjustable frame are easily detached from the motor as well as the propeller. The rudder is provided with rudder lines, which terminate in metal plugs, and these fit into sockets provided on the switch inside the boat; these lines not only serve for steering, as in the ordinary way, but also make the necessary electrical connection between the switch and the motor. A small propeller is fitted on a projecting shaft at the end of the torpedo, and when in place on the stern of the boat lies close up to the keel. This propeller revolves at a high speed when current is supplied to the motor, and it is this which drives the boat. The motor itself is also fitted with a thin metallic fin, which enables the

The New-Mayne Rudder Motor Boat.

rudder to be used in the ordinary way when sailing or rowing. The pivoted point of the motor is where the supporting tube passes through the frame to the yoke, and this takes an ample bearing in the frame, thus avoiding any vibration. The frame is fitted with two thumbscrews, which press small pads against the stern of the boat, and hold it perfectly rigid. It is claimed that, as the propeller moves with the motor, extremely sensitive steering is obtained when the motor is running, and thus the most complete control and manœuvring power to the operator is secured.

The peculiarity of the motor, from an electrical point of view, is that the field magnet revolves inside the armature, which is, of course, of circular shape. The field magnet, which is the revolving part of the mechanism (see drawing), drives, through bevel gearing, a vertical shaft, which passes up the supporting tube already mentioned. The connections from the sections of the armature are taken up the interior of the tube to the segments of the commutator which is fixed at the top of the vertical shaft. The commutator, however, is not in direct connection with the revolving vertical shaft, and is moreover stationary, the necessary commutation being done by the revolution of the brushes, which are carried on a projection of the vertical shaft. In spite of the arrangement of the electrical parts the electrical efficiency of the motors is fairly high. The improvements that have been made are in the better support of the apparatus, and a more mechanical arrangement of the working parts. The armature and field coils are insulated by a patented waterproof composition giving an extremely high insulation resistance, so that any danger of breakdown through "earths" is averted. We are informed that tests of over 500 megohms insulation resistance have been obtained on many of these machines.

The motor is, of course, driven by secondary cells, and there is on each boat a regulating and reversing switch. We saw a skiff being driven by the motor a few days ago, and as far as we could see from a short inspection, the various evolutions of the boat were rapid. The weight of a ½ horse-power motor is about 55 lbs., and a 2 horse-power 200 lbs., this, of course, being exclusive of batteries and switching gear.



Details of Rudder Motor.

Acetylene Regulations in Paris.—The numerous accidents which have taken place in Paris and elsewhere in connection with the manufacture of acetylene and its use for illuminating purposes, have resulted in some stringent regulations which have been issued by the Prefect of Police at Paris. These regulations are for the present merely provisional, and their tenor may be gathered from the fact that manufactories of carbide of calcium and of acetylene, compressed to more than 1½ atmospheres, or liquefied, are to be placed in the first class of dangerous buildings. Manufactories of acetylene gas not compressed, or compressed to less than 1½ atmospheres, if for public use are to be in the first class, whilst if for private use in the third class. It is hoped that these regulations will result in diminishing the number of serious misadventures which have taken place, not only in private establishments, but even in scientific laboratories where acetylene is being experimented with.

TELEGRAPH AND TELEPHONE NOTES.

(*Continued from page* 384.)

Raid on a British Telegraph Office.—A Bushire correspondent writes to the *Times of India*:—"The agriculturalists in the neighbourhood of Bushire have been suffering from the effects of drought during the past 18 months, and in consequence of imminent famine they made a raid on the Government telegraph office at Bushire, imagining that some of the appliances used by the officials were charms intended to prevent a fall of rain. They demolished several instruments, and, curious to relate, a heavy downpour followed this wanton act of destruction, confirming the ignorant peasantry in their superstitious belief. H.M.'s gunboats *Sphinx* and *Lawrence*, which were stationed at the port at the time, were ordered to proceed to the scene of the outrage, in order to render protection to the telegraph staff, if necessary. Their services were fortunately not required, and on a report being made to the Governor of the place, troops were turned out and succeeded in capturing a number of rioters, who have since been severely punished."

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1895 ...	...
West Indies—		
Puerto Plata-Martinique	Dec. 19th, 1895 ...	...
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Jamaica-Colon	Feb. 6th, 1897 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Hong Kong-Macao	Jan. 5th, 1897 ...	...
Assab-Massowah	Feb. 20th, 1897 ...	...
Telegrams are forwarded by boat.		
Landlines.		
Trans-Continental line beyond Mazol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Saigon-Bangkok ...	March 10th, 1897 ...	March 11th, 1897.
	March 11th, 1897 ...	March 12th, 1897.
Siberian lines interrupted near Khabarowka	March 16th, 1897 ...	...

March 15th, 1897.—Telegrams for places in the interior of Ecuador beyond Guayaquil, with the exception of Tulcan, Yaguachi, Milagro, Maranjito, Chimbo and La Libertad, are subject to delay.

Telephone Royalties.—In the House of Commons, on Tuesday, Mr. Henniker Heaton asked the Secretary to the Treasury, as representing the Postmaster-General, what was the amount of money paid as royalty by the National Telephone Company for each of the following years—1893, 1894, 1895, and 1896; and whether he was aware that no particulars of these receipts were specifically given to Parliament in the Postmaster-General's annual report, or in any other public document. Mr. Hanbury replied that the amount for the year 1895-6 was £81,530. The information asked by the hon. member in regard to previous years was given in reply to a question asked by him on March 20th, 1896. The answer then was that the royalty was 10 per cent., and the amount received during the past five financial years were:—1890-1, £44,007; 1891-2, £50,403; 1892-3, £57,620; 1893-4, £65,443; 1894-5, £72,693. The Postmaster-General was aware that no particulars of these receipts were specifically given to Parliament in his annual report or in any other public document, and he did not think it necessary to select this particular item for separate publication.

The Telegraphists School of Science.—The twentieth prize distribution in connection with this school took place on Thursday last week at the General Post Office. The silver medal and first prize of £3 were won by Mr. E. Harriss for telephony, and the bronze medal and second prize of £2 by Mr. A. W. Martin for electro-metallurgy. There were, according to the *City Press*, 61 successes in the examination in magnetism and electricity, 24 in mathematics, and 20 in mechanics. In all 193 successes were recorded, as against 165 in the preceding year.

CONTRACTS OPEN AND CLOSED.

OPEN.

Bristol.—April 7th. The Electrical Committee invite tenders for the supply and erection of condensing plant, steam and exhaust piping, &c. Electrical Engineer, Mr. H. Faraday Proctor. See our "Official Notices."

Galatz.—March 27th. The Secretary of State for Foreign Affairs has received a despatch from H.M. Consul-General at Galatz stating that tenders are invited for the construction and working of a system of electric tramways over a length of about 13 miles of the streets in the town of Braila. The concession is for a maximum period of 35 years. Tenders to be sent to the office of the Mayor in Braila. Such further particulars as have been received may be seen at the Commercial Department of the Foreign Office any day between 11 a.m. and 6 p.m.

Hull.—April 8th. The Electric Lighting Committee want tenders for the following in connection with the electricity supply extensions, Borough Electrical Engineer, Mr. A. S. Barnard:—Boilers, economiser, crane, engines, condensers, pumps, dynamos, transformers, switchboards, batteries, mains, &c. See our "Official Notices" for further particulars.

Islington.—March 23rd. The Vestry wants tenders for an 80 I.H.P. high speed engine, a 35 to 40 kw. alternator, and a 20 kw. continuous current dynamo.

Jamaica.—April 15th. The Privy Council invites applications for a license for the establishment and working of a system of rapid transit in Kingston and environs. Copies of the Tramways Law, 1895, and of local rules and maps of Kingston and environs may be seen at the offices of the Crown Agents for the Colonies, London.

Plymouth.—March 26th. The Corporation is inviting tenders for alternators, dynamos, boilers, condensers, pumps, accumulators, cranes, switchboards, mains, conduits, transformers, arc lamps and posts, and various other apparatus and machinery in connection with the electricity works of the Borough. Borough Electrical Engineer, Mr. J. H. Rider. We would draw the attention of intending tenderers to the supplementary notice signed by Mr. J. H. Rider, and appearing among our "Official Notices" last week.

Portsmouth.—April 2nd. The Corporation wants tenders for the supply and erection of three motor generators and switchboard arrangements, also a battery of accumulators with stands. Engineers, Messrs. Kincaid, Waller & Manville. See our "Official Notices" for further particulars.

Russia.—March 20th. Tenders are being invited by the Municipal Authorities of Ekakrinoslav, Russia, for the concession for the establishment and working of a central station for private and public electric lighting purposes in the town.

Scarborough.—March 24th. The Scarborough Electric Supply Company, Limited, are prepared to receive tenders for the supply of about 1,500 tons of coal for the year commencing April 1st, 1897. Particulars on application to Mr. John Hall, Secretary, 24, Westborough, Scarborough.

South Shields.—March 23rd. The Corporation want tenders for the supply of plant and the carrying out of work connected therewith, including the supply of cast-iron pipes and boxes, trenching and laying pipes, rubber covered cables and laying same, low tension cables and laying same, arc lamps, switches, transformers, incandescent fittings for street lamps. Borough Electrical Engineer, Mr. J. A. Jeckell.

St. Pancras.—March 25th. The Vestry want tenders for supplying bare copper strip conductors in culverts, and laying earthenware conduits. Particulars upon application to the Electricity Department Offices, 57, Pratt Street, N.W. See our "Official Notices" for further details.

Wells.—March 27th. The Lighting Committee wants tenders for the supply and erection of the plant required for the complete equipment of an electric light station and for the underground conductors, &c. Particulars from Dr. John Hopkinson, 5, Victoria Street, S.W. See our "Official Notices."

CLOSED.

Reading.—The Council has accepted the tender of the Brush Electrical Engineering Company for electrically wiring and fitting the Town Halls and Municipal Buildings, and the New Art Gallery, &c., at a cost of £1440.

Southampton.—The tenders sent in for coal for the electricity works have been considered, and two trucks of Dowlais Merthyr coal have been ordered from Messrs. Bradbury & Co. at 17s. 3d.

NOTES.

The Royal Society.—Before this Society yesterday afternoon a paper was read by Prof. Hartley, F.R.S., on "Experiments on the Flame Spectrum of Carbon Monoxide."

Water-Tube Boilers and Liquid Fuel.—In the United States Navy they have been using liquid fuel in a third class torpedo boat. The report dealing with the subject is very brief, and does not state to what type the boiler of the tested torpedo boat belongs. The results were good as regards evaporation, and it only remains to ascertain the safety with which oil fuel can be stowed and used. Oil fuel is to be tried in a tug for test purposes, and it is hoped that ultimately it may be found suitable for general use in both tug and torpedo boats.

New Insulating Material.—An American contemporary states that a new material for insulating purposes, which is claimed to be absolutely waterproof for underground work or in damp places, is being placed on the market by the Fiberite Company. The material is in the nature of vulcanised fibre, and will quickly adapt itself to many uses where a perfect insulation is required. It can be used in the construction of dynamos and motors, but is specially adapted to underground street railway work, for insulating track work, block signal purposes, and anywhere where vulcanised fibre is used. This material has been thoroughly tested, and, we are told, seems to have stood all the tests in a satisfactory manner.

The Electric Arc for Lantern Projection.—The projection of a concentrated light upon a surface for illustrating and other purposes has, within the last few years, become so important, that it is by no means surprising that many minds have been brought to bear upon the subject, and with successful results. A great many forms of illuminant are made use of; thus we have oil lamps, coal gas, the incandescent gas lamp, acetylene gas, the oxy-hydrogen light, the incandescent electric light, and the electric arc. In the opinion of E. P. Hopkins, writing in our contemporary the *Electrical Engineer* (U.S.A.), the electric arc far surpasses all other forms of light, most of the others being encumbered with difficulties. The writer considers that the oil lamp is the least successful; then comes coal gas, which is almost twice as strong when used in a Welsbach burner as regards white light, as most oil lamps. Next it places acetylene, which he considers to be four or five times as valuable as only gas or oil, whilst the oxy-hydrogen or lime light, when compared with acetylene, exhibits a ratio of 7 to 5 as regards value. He then puts the incandescent electric light with the filament in the lamp, coiled into a small spiral, as giving the next best results, and finally he considers the arc light as the most perfect and ideal illuminant for all optical projection work. The principle of all projections is to illuminate the object which is to be projected as brilliantly as possible. The light radiating, transmitted or reflected from the object, is concentrated by an objective lens upon the surface where the projection is to be made. In projecting any object that itself gives out light, such, for instance, as a candle, all that is necessary is an objective lens which will concentrate the rays of light upon the screen; but when the object is transparent or opaque, the problem is different, for the subject must be illuminated so brilliantly, that the rays of light passing from it to the objective must be bright enough to be distinctly seen upon the screen. The paper is illustrated by diagrams which thoroughly bear out the views of the writer. He calls especial attention to the importance of having a very short focus, and considers that 3 inches is a perfectly safe distance for the electric arc when using 7 to 18 amperes, always provided that the lenses are mounted sufficiently loosely so as to enable them to expand as they become heated. In order to get the most perfect concentration of light from these lenses, it will be necessary to have the illuminant as small as possible, that is to say, to be as nearly as possible a point of light. In the oxy-hydrogen or calcium light, the illumination is spread over fully $\frac{3}{4}$ inch of the lime cylinder, its entire width being $\frac{1}{2}$ inch; while with the electric light, when giving fully twice or three times as much illumination as that of the lime light, the surface is not more than $\frac{3}{16}$-inch in diameter. This is at the extreme point or crater of the positive carbon giving 80 per cent. of the entire light. In order to obtain this light, and to avoid the spot of light from the negative carbon, the lamp is tilted, so that the point of the positive carbon points towards the condensers. By this concentration of light, a very minute focus is obtained, so that we can bring the concentrated rays of light from the condenser to pass through an aperture not more than $\frac{1}{8}$th of an inch in diameter. This is very necessary for all microscopical projections where one has to illuminate a large field or screen with an aperture in the lens of not more than $\frac{1}{16}$-inch. The best results with the microscope are obtained by using extra condensing lenses, so that very little of the light is lost. With the limelight, and all other illuminants, we cannot concentrate the light to a very small point, on account of its emanating from such a large surface. It is also found, on account of the electric light emanating from such a small point, that the rays of light passing from the lenses or reflectors can be refracted or reflected so perfectly that they will extend to any distance, making the only perfect form of search light. Another point of greater consideration in lantern projection is that the electric arc light, although so intensely brilliant, does not radiate much heat. Thus the illuminating power of the electric lantern is almost unlimited. Using the electric lamp with from 18 to 20 amperes, the same condensers may be used as those for the oxy-hydrogen. In a forthcoming paper, the writer will deal with the use of incandescent electric lamps in connection with lantern projection.

Another Application of the Electric Furnace.—In the production of nitrogen compounds, in which ammonia is a final production, a new system of manufacture has been devised by T. Wilson, of New York. His system may be briefly described as follows:—A compound of metal or metalloid is subjected to the intense heat of an electric furnace together with carbon in a current of nitrogen, to obtain a nitride, or in some cases a cyanide, from which ammonia may be produced. The apparatus consists of a pump by which air is forced into the bottom of a converter in which fuel is burned; a dust-separating chamber into which the nitrogen and carbon oxides from the converter are passed, and then conducted, either into the bottom or side of an electric furnace, or through the carbon electrode of the furnace, hollowed for the purpose. As an example of the process, a mixture of magnesia with granulated coke or coal dust is heated in the manner described, to obtain magnesium nitride, which, when treated with water, yields ammonia. Nitrides of silicon, boron, aluminium, calcium, titanium, barium, &c., may be similarly produced. When barium compound is used, however, a large proportion of barium cyanide mixed with the carbide occurs. In the manufacture of metallic cyanides and other nitrogen compounds, Wilson observes the following process: Nitrogen is brought into contact with a carbide of a metal or metalloid, either simultaneously with the formation of the carbide from an oxide of the metal and carbon by electric smelting or otherwise; or when the carbide has been tapped off and is still in a molten state, or a carbide, after cooling, may be fused and subjected to the action of nitrogen. The apparatus described, consists of an electric furnace and accessories made for running off the molten carbide from the furnace into an adjacent receptacle, a branch pipe in the latter conducting the mixture of nitrogen and carbon monoxide gases derived from the combustion of fuel. The pipe has also another continuation into the electric furnace, so that the conversion of the carbide into cyanide may, if desired, be effected before the carbide is run off. Examples are given of the formation of calcium and barium cyanides from oxygen compounds of those metals, fused with carbon and treated with nitrogen, and the process is stated to be applicable to the metals of the alkalies, as well as to silicon. Cyanides obtained as described may be decomposed by superheated steam to obtain ammonia; or the cyanides of calcium and barium, for instance, may be decomposed by an alkali chloride to obtain an alkali cyanide.

The Glasgow and West of Scotland Technical College.—The annual report of this college, which has recently been issued, states that with the annual meeting the governors have completed the first decade of their administration of the Technical College. The number of subjects taught has increased in this period from 16 to 39 in the day classes, and from 34 to 65 in the evening classes. The number of students has increased from 1,793 to 3,327. The electrical engineering workshop and laboratory, under Prof. Jamieson, has been attended by over 40 students in the day classes, and the enrolment of students for the evening classes on magnetism and electricity (Prof. Jamieson) to December, 1896, has been 187, magnetism and electricity (Prof. Blyth) 87, electric lighting 160, telegraphy 60. It may be remarked that the number of enrolments of students for the latter subject to December, 1895, was but 31, the increase to 60 being, doubtless, due to the examination system for promotion carried out by the Postal Telegraph authorities. It is worthy of note, as showing the vast interest taken in electrical technics, that in but two other subjects, viz., "Building Construction" and "Mathematics," are the numbers of enrolments exceeded by that of the electrical section.

The Explosive Properties of Acetylene.—We strongly advise those who are contemplating a trial of acetylene as an illuminating agent to study a paper by Berthelot and Vieille, which is given in the *Comptes Rendus*, Vol. 123 (14), pages 523 to 539. These well-known experts of explosives have investigated the conditions under which acetylene explodes, and the precautions which should be observed in dealing with it. They point out that acetylene is an endo-thermic compound, the decomposition of which into its elements produces about as much heat as the combustion of an equal proportion of hydrogen. It can be exploded by the action of fulminate of mercury. When under the pressure of two or more atmospheres, it exhibits all the properties ordinarily observed in the case of explosive mixtures. The effect of high temperatures and pressures increases the speed of decomposition as the initial pressure is increased. This increase is very rapid as the pressure at which acetylene liquefies is approached. Decompostion is propagated in liquid acetylene under pressure as easily as in the gas, and though blows and shocks do not of themselves start explosions in receivers containing this liquid, yet if such a receiver becomes smashed by a blow, an explosion usually follows immediately. But the steel cylinder in which acetylene is stored has been exploded by means of a hot wire. Too rapid condensation of the gas, or the sudden opening of a stop-cock, the presence of a small quantity of water together with calcium carbide in a closed vessel, and the existence of impurities in the carbide, have all been observed by Berthelot and Vieille to result in an explosion. These chemists are of opinion that all the above-mentioned risks can be guarded against by proper care in the preparation and manipulation of the gas, and that they do not constitute a serious bar to its use as an illuminating agent, to which we have to reply that though in the hands of such skilled chemists as those above entitled, who are used to handling the most dangerous explosives—even large quantities of nitro-glycerine—it can be safely dealt with, yet the ignorant consumer of acetylene as an illuminant is incapable of knowing how to take these precautions.

The New Rubber Industry in Lagos.—It is very interesting to find that, in spite of repeated threats that rubber famines are upon us, new sources of supply continue to be opened up, and it is very gratifying to hear that one of the youngest of these new sources is on British territory. The rubber industry of Lagos affords one of the most remarkable instances of the rapid development of an industry that has taken place in recent years in any British colony. It owes its existence to a wild plant which was only discovered in Lagos within the last two or three years. It was found to be new as a source of rubber, although there is now reason to believe it had yielded some of that formerly exported from the Gold Coast. At the present time Kickxia rubber from Lagos has established itself as a commercial article in great demand. The exports in January, 1895, were 21,131 lbs., of the value of £1,213. This was practically the beginning of the industry. In December, 1895, the exports had increased to 948,000 lbs., of the value of £51,488. From a recent return communicated to Kew by the Government of Lagos, the total exports during the year 1895 amounted to 5,069,504 lbs. (2,263 tons), of the value of £269,892. This considerable industry has therefore been called into existence within 12 months. The rubber is purely a forest product, and the collection and preparation of it have been effected by means of native labour. The success of the industry is another indication of the undeveloped resources of our West African colonies. It is only a few years ago that a somewhat similar, though more gradually developed rubber industry, was called into existence at the Gold Coast. The origin of this is given in the following extract from a Colonial Office report on the economic agriculture of the Gold Coast in 1889:—"Although the youngest of our industries, the preparation of India-rubber is now only second in importance to that of palm oil. Attention was first drawn to this valuable product by Sir Alfred Maloney (now Governor of Lagos), when administering the Government of the Gold Coast Colony in 1882, by letters to the local press. The first practical experiments were made by Mr. F. C. Grant, of Cape Coast, whose example was quickly followed by others, and the undertaking proving remunerative, the collection of rubber began in every part of the colony. The quantity now produced annually ranges from £30,000 to £40,000 in value.

A Comparison of the Multiple and Series Systems of Copper Refining.—Copper refining by electrolysis has made rapid progress in the United States, some manufacturers depending upon the multiple, and others upon the series system of vat working. In the former, the vertical electrodes are hung on copper bars, which serve as current conductors, and run along the length of the vats. In the series system, only the first and last plates in a vat are connected to the current conductors; all the intervening ones being insulated. Although the latter arrangement has been much experimented with in the United States, it is now being given up. Barnett states that in comparing the working of these two systems, one must note:—(*a*) Current efficiency; (*b*) Amount of copper locked up in the vats; (*c*) Working costs; (*d*) Capital outlay on plant. The multiple system (M) requires low E.M.F., and gives 95 per cent. of efficiency; the series system (S) requires high E.M.F., and, owing to short-circuiting through the vat walls and silver mud, the current efficiency is only 85—90 per cent. The locked-up copper is only half as great with (M) as with (S), whilst much more impure anode copper may be safely used. The capital outlay is greater with (M) than with (S). Balancing these various items, the total cost with (M) is found to be about 8s. 4d. per ton of refined copper less than with (S). The Anaconda Refinery has changed its entire system from the series to the multiple. The subject is fully dealt with by G. Kroupa, in the *Oesterr. Zeits. Berg. u. Huttenw.*, Vol. 55, page 541.

Institution of Electrical Engineers.—The next visit of the students of the above Institution will be to the Islington Central Station, on Thursday, March 25th. The party will meet at 50, Eden Grove, Holloway, N., at 4.15 p.m. Those desiring to join the party should at once give notice to that effect to the secretary of the Students' Committee (Mr. W. Bunn, 23, Oxford Road, Stroud Green, N.). As the number will have to be limited, applications will be dealt with in order of receipt.

The Effect of Removing the Ends of a Magnet.—It is well known that when a magnet is cut so as to divide it into two parts, two complete magnets are formed, whose poles are arranged in the same way as in the large magnet before cutting. It has occurred to J. F. Smith to ascertain the effect of cutting from the ends of a wide thin magnet, strips whose width is small compared with their length. His experiments are described in a recent issue of the *Western Electrician*, and are illustrated by diagrams showing the effect of removing the ends of the magnet in various ways. These experiments seem to indicate that when a wide thin magnet is cut or broken so that the part removed has a length greater than its width, the arrangement of the poles is different from that ordinarily obtained by cutting the magnet. On a consideration of the nature of the behaviour of Faraday's lines of force, the explanation seems to be as follows:—At the regions where the lines of force enter or leave the magnet, the poles are located. Each line of force is a closed circuit running from pole to pole through the magnet, and making the return circuit through the air. When the magnetised strip of steel has got *almost* across, the lines of force are diverted from their usual path through the magnet, and are crowded together, the narrow portion joining the small strip at the end to the larger magnet. Since the strip furnishes a better path for the lines of force than the air in the gap where the metal is cut, the lines are thus shifted, so that they run lengthwise of the strip instead of crosswise. The lines of force then leave the strip at the ends or near the ends. When the small strip is being broken from the main strip, the lines of force leap across from the larger strip to that point of the small strip which is nearest the large one, and thus the formation of a separate pole begins. When they are completely separated, this lost point, at which the strips were joined, becomes a separate induced pole, permanent, and of opposite kind to the adjacent pole of the larger magnet. Essentially the same thing takes place when the strip is cut from the sides towards the middle, the results being the formation of a north-seeking pole at each end, whilst the consequent south-seeking pole is induced at the middle, where the lines of force leap across from the larger magnet.

Experiments in Oxidation by Means of Electrolysis.—During the electrolysis of a dilute solution of sodium sulphide, it was recently observed by F. W. Durkee that hydrogen gas was evolved at the cathode, and ultimately throughout the body of the liquid. Light yellow sulphur then appeared on the anode, but scaled off again and chiefly dissolved. Fine white sulphur next separated near the surface of the liquid above the anode, but dissolved as it sank through the solution until a certain stage of the electrolysis was reached, when the yellow colour of the liquid disappeared, and the white sulphur settled in the beaker; subsequently more oxygen escaped than at any previous stage. This separation of sulphur appeared to connote oxidation, and the effects observed in connection with the analytical data, given in the paper in which Durkee describes his work (*vide American Chemical Journal*, 1896, Vol. 18, page 525), indicate that the course of oxidation of sodium sulphide, for example, by electrolysis, is similar to that of its oxidation by air. During electrolysis, first the sulphides disappear, then the hydroxide, then the thiosulphate, the end product being the sulphate. It may be noticed that attempts which were made to electrolyse sodium sulphide solution with an alternate current failed, the platinum electrodes dissolved; no such dissolution, however, was noticed in the case of direct current electrolysis.

Cotton Bleaching by Electrolysing Prepared Solutions.—Meeting with considerable difficulties in the industrial application of the electric bleaching process, A. Vogelsang, of Dresden, has recently devised improved apparatus with which he is said to have achieved perfectly satisfactory results. The cotton yarn should be closely packed in very concentrated liquors, prepared in a vessel (the electrolyser), through which flows a solution of rock salt, while, at the same time, an electric current from a dynamo machine circulates through the liquid. The bleaching liquid obtained in this manner is kept in closed vessels until required for use. The advantages of the electric bleach are thorough and even bleaching, and, compared with the use of bleaching powder, less liability to tender the cotton, and decreased cost. Although the initial expenditure is somewhat great, the cost of working is low, and, at present prices, a bleacher could recoup himself in two years for his initial outlay. The cost of the necessary plant, exclusive of buildings, is about £425, made up as follows:—Electrolyser, £180; vessels for boiling and bleaching, each to hold 1,500 lbs., complete with pump, £75; dynamo machine, which can also be used for electric lighting purposes, £45; squeezing rollers or hydro extractors, £30; washing machine, £75; various wooden casks, £20. Two men can bleach and wash off 1,500 lbs. of yarn a day. It is very important to note that a water supply, which is quite unsuitable for bleaching by the ordinary method, is equally unsuitable for the purpose of electric bleaching. The original of this abstract may be found in the *Leipziger Farber and Zeugdrucker Zeitung*, Vol. 45, pages 449 to 451.

Porous Carbon Cylinders for Electrolytic Work.—In the form in which Bunsen first introduced the cell which bears his name, it contained no porous cylinder. The carbon was in the form of a hollow cylinder, containing the oxidising liquid, and this dipped directly into the dilute acid containing the zinc. The carbon rod and porous cylinder were only introduced later. For the purpose of performing organic electro-syntheses without a primary battery (the organic substance forming part of the cell itself), W. Lob has endeavoured to get rid of the usual porous cell, which offers considerable resistance. The most convenient way of doing this is to use moulded carbon cylinders as porous cells. In its conducting power carbon nearly approaches the metals, and when used in this way it acts as an intermediate conductor. Electrolysis takes place on both sides of the carbon cylinder; if the anode be immersed in the outer liquid, the outside of the cylinder plays the part of a cathode, and the inside that of an anode. Its behaviour, then, is two-fold. It behaves as a porous diaphragm, through which ions pass freely. It also behaves as a solid conductor, of which the two surfaces act as anode and cathode respectively. For example: An anode of platinum foil is immersed in a beaker containing dilute sulphuric acid; a hollow carbon cylinder containing copper sulphate is used as cathode. When the circuit is closed, oxygen is evolved at the anode. A few bubbles of hydrogen rise from the outside of the cylinder, but the amount is very small compared with the oxygen. After an hour, copper is found to be deposited on the inside of the cylinder, mainly on the part nearest to the anode. If we use as cathode a carbon rod dipping into the copper sulphate in the cylinder, copper is deposited on the cathode and also on the outside of the cylinder. When a carbon cylinder is used directly as an electrode, we might expect it to behave simply as a metallic electrode, the electrolytic action taking place only outside it, in the liquid which surrounds the cylinder, and in which the second electrode is immersed. But experiments made by Lob on this point indicate that the expectation is not realised. He concludes that when a carbon cylinder is used directly as a cathode (or anode), its whole surface, both inside and outside, behaves as a cathode (or anode). Lastly, he finds that when a cathode (or anode) is brought into metallic connection with a carbon cylinder, so that both are at the same potential, the whole system behaves as a cathode (or anode), the result being simply to increase the active surface. The original paper may be found in the *Zeitschrift für Electrochemie*, Vol. 3, pages 185 to 187.

A New System of Applying Electrolysis in the Extraction of Metals.—A method which possesses sufficient novelty to justify its notice in these pages is essentially as follows:—The ore is roasted and then mixed, either in or out of the furnace, with a quantity of solid or liquid chloride of iron, or with hydrochloric acid, or some chloride. A quantity of water is added to the mixture in suitable vats, and chlorine gas passed into it, the whole being kept hot by steam or hot air. The mixture is then leached with water, containing acid if convenient, and washed with water until free from copper, zinc, or tin. The residue, if it contain lead, silver or gold, is smelted or treated by any well-known process. The clear solution, after passing through a further quantity of ore, is run into covered vessels having one or more compartments, each containing anodes and cathodes. A current of electricity deposits the metal on the cathodes and liberates the chlorine of the anodes ready for further use. The gold and silver which enter into solution are precipitated with metallic copper or zinc. The solution is then treated with a small quantity of oxide of copper or oxide of zinc to precipitate the iron, after which it is electrolysed to obtain the copper, zinc, lead or tin.

Purification of Beetroot Juice by Electricity.—A. Baudry (*Oestr. ungar. Zeits. Zuckerind, und Landwirth*, 1896, 35, 238), makes an interesting communication on the working of the electrolytic method of Schollmeyer and Huber in the Russian sugar works, Stepanowka and Waronowitza. After the diffusion juice leaves the measuring tank, ¼ per cent. of lime is added, and it is passed through a heater to be heated at 80° C. It is then electrolysed in a rectangular reservoir, with zinc electrodes. A gradually thickening mud forms, and a sticky deposit on the cathodes, which would cause great resistance to the current, unless removed from time to time by reversing the current, when it falls off. In 15 to 20 minutes the juice, now of a fine yellow colour, is passed to the saturators. From this point outwards, the action of the electrolysis is seen in a saving of 40 to 50 per cent. of lime, less foaming, and consequent saving in grease of 60 to 70 per cent. The filter presses work better, and gives 20 to 25 per cent. less cake, so that there is a saving in cloths, in wash water, and in labour. The evaporation is easier, the massecuite freer and more easily centrifugalised. For a daily work of 409·5 tons of beets, a current of 850 amperes at 5·5 volts suffices, requiring a motor of a little over 7 H.P. The author calculates that on working up 32,800,000 kilos. of beetroots, there is an actual saving by electrolysis of 14,470 roubles. The tests have plainly shown that the use of electrolysis alone as a method of purifying raw juice is impossible, as it is irrational to place the more expensive electricity in opposition to cheap lime. Schollmeyer conceived the happy idea of employing them in conjunction, and herein lies the secret of the results of his process. Electricty, instead of opposing, now completes the action of the lime, and acts, moreover, on certain parts of the non-sugar, which lime, even used in large quantities, could not affect. Electrolysis precipitates almost three times the nitrogenous matters that are removed in the ordinary separation.

Electricity and Electrical Vibrations.—In the second of his course of lectures delivered at the Royal Institution last Saturday, Lord Rayleigh continued, says the *Times*, his discussion on the subject of induction. The current induced in a secondary circuit by the making or breaking of the primary might appear instantaneous, but of course in a mathematical sense that was impossible; it in fact rose suddenly to a *maximum*, and then faded away gradually but rapidly. The galvanometer showed the aggregate of the induced current, and only by means of difficult and complicated arrangements could it be used to indicate the highest value of the current before it began to fall off. One way of investigating this was by measuring the amount of permanent magnetism produced in a steel needle placed within a coil of wire through which the induced current passed, since the intensity of the magnetism it received would depend on the initial *maximum* strength of the current operating on it. Lord Rayleigh then passed to the consideration of self-induction, which he described as analogous to inertia in mechanics, and showed by an interesting experiment its influence in governing the amount of current passing through a given circuit. Several incandescent lamps were brightly lighted by an alternating current passing through a coil of wire. But when the self-induction of the circuit was increased by putting a bunch of iron wires within the coil, the filaments of the lamps were reduced to a dull red heat. It was shown that this effect could be undone by completing the circuit of a secondary coil wound round the first one, the lamps thereby being made to glow as brightly as before. Another example of the effects of self-induction was shown in the use of a single Daniell cell for the decomposition of water. With several cells that effect could easily enough be obtained, but with one alone there was no appreciable decomposition, because the chemical action of the Daniell cell was not of itself adequate. But associated with a self-inductive circuit, one cell was quite sufficient to decompose water. Lord Rayleigh also said a few words about circuits which were completed, not metallically, but through air of various degrees of rarefaction. In some respects he thought more could be learnt about the nature of electricity from the phenomena produced in such cases than from those exhibited by closed circuits.

Lectures.—On Wednesday last, Prof. Silvanus P. Thompson lectured at the Crystal Palace on "Electrical Discoveries and Inventions during the Queen's Reign."

Under the auspices of the Aberdeen Mechanical Society, Mr. Walter Dixon delivered a lecture last week on "What Electric Power Transmission might do for Aberdeen."

At the Royal Institution, Swansea, on 8th inst., Mr. Reg. Wallis-Jones delivered a lecture on "Electricity."

The Institution of Electrical Engineers.—On Thursday next, March 25th, 1897, the discussion on Capt. Benest's paper, "On Some Repairs to the South American Company's Cable off Cape Verde, 1893 and 1895," will be continued.

The Forthcoming Celebrations and Electrical Illumination.—The celebrations in connection with the forthcoming Diamond Jubilee, give every promise of surpassing in grandeur and extent those of 1887, and of the marriage of the Duke of York. Not only will there be additional attraction in the general arrangements, but in the matter of illuminations there will probably be such a display as London has never before seen, and electricity will be largely called into use for this purpose. Since the 1887 celebrations, there have been laid beneath nearly all important London thoroughfares, electric light mains for both street and private lighting, and we may therefore be justified in looking forward to a pleasing display of effective electrical illumination, the more so as the public streets are lighted by arc lamps as well. The City of London Electric Lighting Company, and the other companies through whose districts the procession will pass, should have an extra good summer season, while electric wiring and fitting contractors should also find plenty to do in decorating the exterior of City establishments in as artistic a manner as possible. The larger houses are already making the necessary arrangements. At the Mansion House, of course, there will be a grand display of electric lamps.

Caution.—We have before us the prospectus of a company about to be floated under most plausible recommendations, and a proposed capital of £100,000, for the exploiting of a primary battery. The prospectus is marked, "For private circulation only," and we therefore abstain from publishing details too severely, to individualise or identify the scheme. But as we have reason to believe that certain of the public are already negotiating for shares, we feel that we shall not be transgressing any law of decorum in mentioning a few matters *not* included in the prospectus. To begin with, no electrical expert's report is among the printed opinions. No information is given as to whether the patent refers to a new battery, or merely to an old battery in a new box, or simply to a new box. No evidence appears from which it is possible to determine that the company, by its purchase of the patent, gets any monopoly of any single essential part of a primary battery. No hint is given as to whether the electrodes will endure for 10 years, or 10 hours. In consideration of the enormous capital, and the risk to the public, we are greatly tempted to deal more severely with this matter. We await the public announcement and in the meantime hope that financial newspapers will assist us in our attempt to avert what we believe to be a bubble scheme.

Natural Waters and their Effects on Steam Boilers.—Referring to the action of scaling water upon boilers, Mr. G. W. Lord, in the *Electrical World*, speaks of the use of hydro-carbon oils. He says that though much used during the past few years, their use has now been discovered to be dangerous. He says that mineral oils will get in between scale and plate, and detach the scale in large pieces, and allow the heated plate to be suddenly quenched, which is dangerous, from the local contraction which ensues. He objects to all fluid compositions, as they contain so much gummy or resinous material, and considers the most successful re-agents are those which include such chemicals as sodium fluoride, sodium tannate, tri-basic sodium phosphate, and barium salts in suitable proportions. These salts convert the scale forming salts into a soft flakey substance, which does not deposit, but is kept up by the water currents. He particularly emphasises the leakage which will arise where hydro-carbon oils are used, and the liability to overheat the plates, which has been so often denied. Too much care cannot be exercised in respect of boiler compounds. They are very apt to be dangerous, and many of them are very impure, and form scale to add to that otherwise present. Many compounds also form a thick gummy water, and this will not circulate, nor come to close contact with the heated plates, and many a boiler crown has been brought to grief from filthy compounds forming as thick and slab a compound as any trio of witches in a cauldron: while treatment in the boiler may be at times compulsory, or appear so to be, it is a question whether in most cases the feed to a boiler cannot be treated before it enters a boiler. We have no doubts on the question at all where the scale forming matter is mainly carbonate of lime, or even lime sulphate, and have seen such waters treated with the result that practically no scale was formed in the boilers. Already there are on the market various forms of apparatus for either softening water or preventing scale, and the present writer would not hesitate to undertake the cure by one or other system of 19 out of 20 boilers now troubled with scale. Mr. Lord does not name these appliances at all, but seems to pin his faith to compounds, which at most can but prevent scale from sticking too fast to the plates.

Train Lighting.—In consequence of the satisfaction afforded by their electrically lighted trains, and also in order to meet the wishes of the Board of Trade for trains to be lighted in the day time when passing through tunnels, the directors of the London, Brighton and South Coast Railway have given orders for all new and renewed block trains to be in future fitted with the electric light. This company has now 42 electrically lighted trains running, out of which it is estimated that 15 per cent. more work is obtained than from trains not so fitted, through their being always ready to go anywhere, and not needing to be hauled to gas charging stations.

Electric Motors in Persia.—The *Times* Teheran correspondent says that beet-root sugar is now for the first time being manufactured in Persia, a Belgian company, which for the last two years has been erecting a magnificent factory on the newest principle, equipped with electric motors, having begun work early in February.

The Pawtucket Railway Power Plant.—This plant is described in the *Electrical Engineer* (New York). It contains five pair of 33-inch McCormick wheels on horizontal spindles, with flumes of 10 feet diameter, and the fall is only 17 feet, the total power being 1,300 H.P. On the extended 6 inch spindles of the wheels are placed a pair of 9-feet pulleys, 29 inches face. Between the two pulleys is a clutch. One pulley is driven by a steam engine on the floor above, and the other drives a dynamo, also on the floor above. In this way the dynamos can be driven by either engine or turbine, or both, and any supply of water, however small, that will aid the work can be utilised. This can be, of course, told at once, we should say, by watching the couplings when not gripping, so that when the wheel side overruns the other some work can be got out of the water. We have known a case where an old water wheel was credited for seventeen years with saving coal, but had to be stopped finally for repairs, whereupon the poor steam engine nearly ran away with the load. It had been turning the wheel all those weary years. True, the wheel was capable of some work, but the gearing was wrongly speeded, and had it been of a different ratio some duty might, perhaps, have been got out of it. All the units serve to the same bus bars, and though each unit has its own governor, all the wheels govern equally, and the gates of all move alike. The governors are made by the Lombard Water Wheel Governor Company, and usually control to 3 per cent., or within 5 per cent. when a circuit breaker opens, for about 15 seconds. The steam plant is arranged with economisers and fan draught, with a stack simply sufficient to carry the gases above the roof. Evidently, after years of neglect, our American friends are beginning to appreciate the English economiser. Perhaps, in the same number of years, we in our turn will begin to make a more liberal use of the fan. The Americans have very properly applied fans to economiser plants, which, unless accompanied by the tall and roomy chimneys of the north country, are apt to have poor draughts. The generators are 6 pole 150 kw. at 400 revolutions of General Electric Company railway type. They are wound for 500 volts at no load, and over compounded to give 550 volts at full. The whole of the plant, engines, dynamos, and turbines appears, from the perspective view, to be standing in a space 55 feet × 50 feet × 35 feet. The buildings are of brick, with flat roofs asphalted and gravelled.

Utilising the Nile.—It is stated by several London papers that the Egyptian Council of Ministers has approved of the appointment of Prof. George Forbes to examine the Nile cataracts and prepare an exhaustive report regarding the best methods of utilising the water-power available for generating electricity. It is expected that Prof. Forbes will commence his investigations in the autumn.

The Electrolytic Preparation of a New Class of Oxidising Substances.—An interesting piece of practical work, undertaken as a direct corollary of a theoretic deduction, occurs in the *Zeitschrift für Electro-Chemie*. It is believed that when carbonates of the alkalies of ammonium are dissolved in water, they are dissociated into ions (+ M_2 and − CO_3), and when they are electrolysed we get at the cathode, hydrogen, and the hydroxyl compound of the alkali or ammonium and at the anode, oxygen and a bicarbonate. Now, it might be expected that if water were added gradually to the solid carbonate, the dissociation would take place in stages. Ions + M and − MCO_3 being first formed, and complete dissociation into three ions occurring on further dilution. Under suitable conditions, the ions − MCO_3 might unite into new molecules, $MCO_3 - MCO_3$, just as persulphuric acid is obtained from sulphuric acid. The writers of this subject in the *Zeitschrift*, namely E. J. Constam and A. von Hansen, find that this theoretic conclusion is practically true. When a saturated solution of potassium carbonate is electrolysed, the evolution of oxygen at the anode diminishes as the temperature is reduced, and a bluish powder is formed, which upon analysis responds to the formula, $K_2 C_2 O_6$, which is potassium percarbonate. Other percarbonates have also been obtained by following out this plan. It seems extremely likely that these new oxidising substances may find considerable application in industrial arts, but, of course, their behaviour has to be carefully studied. So far, it has been observed that the potassium percarbonate acts very carefully as an oxidising agent in the presence of oxidisable substances, bleaching indigo solution, cotton, silk and wool, and rapidly oxidising lead sulphide into the sulphate. Curiously, too, under certain circumtances, the percarbonate acts as a reducing agent. The interesting feature of this research, perhaps, to us, is that it shows how substances hitherto unknown can be formed by merely modifying the conditions under which other substances are electrolysed. Altogether, Constam and von Hansen's paper is a very suggestive one.

Fire.—On 12th inst. a fire occurred on the upper storey of the electric light department at Queen Street Railway Station, Glasgow, £500 damage being done.

Appointment Vacant.—The St. Pancras Vestry are in want of a distributing engineer, at a commencing salary of £200. See our "Official Notices" for further particulars.

A New Feed Heater System.—In order to save something of the latent heat in exhaust steam, the manager of the engine department at the Elsinore Works, Mr. K. Lund Koist, has devised a new feed heater, which is heated by steam from the low pressure receiver. The steam in this receiver has a temperature of 105° to 115° C., and, as this steam has already done work, it is clear that to use it in feed heating is to work it to such an extent in a closed cycle with a thermo-dynamic efficiency of 100 per cent. The steam which is not thus treated only gives about 15 per cent. thermo-dynamic effect. With an engine of 635 I.H.P., the heater had 200 square feet of heating surface, and the feed was heated to 100° C. as against a feed of 44° only without the heater. About one-tenth of the total steam is abstracted from the receiver. Thus one-tenth is prevented from working in the low pressure cylinder, and the loss thereby is 3·29 per cent. The heating of the feed shows an economy of 9·18 per cent., and a further economy of 6·17 per cent. is gained by the discharge of air from the hot feed. The net economy is 6·17 + 9·18 − 3·29, or 12 per cent. The hot feed separated out its grease very freely, and this was made to collect in the feed heater, which was specially arranged to allow of this, and the skimming off of the grease at intervals. The total thermo-dynamic effect of the steam used is stated to be 20 per cent., which is claimed as a record. The engines tested were triple expansion surface condensing marine engines, with 17 inches, 27½ inches, and 46·4 inches cylinders, and 33 inches stroke, working at 175 lbs. The principle of the heater is simply that of using steam for heating purposes, which has performed work, and returning all the heat remaining in it to the boiler. The work done by this proportion of steam is practically obtained for nothing, though, of course, the abstraction of the steam between the last two cylinders ought to be balanced in the engine design by a reduction in the ratio of the low pressure cylinder. The gain due to the elimination of air will not hold good to the same extent in many stationary plants where the feed is drawn from a many times used source already fairly free from air.

Terrestrial Magnetism.—Before the Royal Geographical Society on Wednesday, Mr. E. A. Reaves read a paper on "Some Notes on Terrestrial Magnetism, with Special Reference to the Positions of the Magnetic Poles."

Electro-Harmonic Society.—The next concert, which is to be held on Friday, March 26th, will be the last of the season, and as the programme is a good one, a large gathering may be expected.

The Electrolysis of Hydrochloric Acid.—An interesting lecture experiment, to show the electrolysis of hydrochloric acid, is described by J. M. Pickel in the *Berichte der Deutschen Chemische Gesellschaft* (*vide* 1896, Vol. 29, pages 1942 to 1945). The production of less chlorine than hydrogen when this acid is electrolysed has already, to some extent, been obviated by L. Meyer, but Pickel describes a form of apparatus in which the electrolyte is the only liquid through which the escaping chlorine must travel. The gas itself is not measured, but is caused to displace its own volume or air, which can then be estimated. An improved apparatus for demonstrating the volumetric composition of hydrochloric acid by electrolysis is also described by G. L. Higley and B. J. Howard in the *American Chemical Journal*, 1896, Vol. 18, pages 584 and 585. The liberated gases traverse but a small layer of the fluid, and are collected and measured in tubes quite distinct from those containing the electrodes. In the *Chemicke Centralblatt*, Vol. 76, page 3, F. Oettel describes the electrolysis of hydrogen chloride without a membrane. If hydrogen chloride is electrolysed without a membrane, the decomposition products are formed in amounts far below the theoretical, as the chlorine which dissolves in the liquid is again converted into hydrogen chloride by the hydrogen at the cathode. The solubility of the chlorine in the solution is reduced by the addition of sodium chloride, magnesium chloride, or magnesium sulphate. The most suitable solution for electrolysis is a concentrated solution of sodium chloride, to which sulphuric acid has been added. If the sulphuric acid is added in excess, oxygen is liberated towards the end of the process; if sodium chloride is in excess, sodium hypochlorite is formed, and the evolution of gas ceases when the solution becomes neutral.

Mechanical Stokers.—In the race for the honour of showing the smallest cost per unit, those in charge of central stations should not hesitate to investigate everything conducive to economy, and in this connection central station engineers would do well to note the developments from time to time in mechanical stokers. For instance, Messrs. Bennis & Co., of Bolton, now claim to be able to reduce the coal bill, give more steam, and a smokeless chimney. The firm is willing to inspect any plant, and then give a specific guarantee as to saving, increase of steam production, &c. It would then rest with the engineer to decide upon the adoption of patent stokers and furnaces or not. Mr. James Proctor, of Burnley, also guarantees a minimum saving of 10 per cent. with his new system of coking stoker, and gives a list of 14 very large firms in England who have this stoker at work in an aggregate of 526 furnaces.

Personal.—We regret to learn that in consequence of an accident while riding last Wednesday, Mr. H. Cuthbert Hall has been medically advised to abstain from all professional work for several weeks to come.

NEW COMPANIES REGISTERED.

Nalder & Hilton, Limited (51,603).—Registered March 11th with capital £20,000, in £1 shares, to adopt an agreement with N. F. Nalder and J. G. M. Hilton, and to carry on the business of electricians, engineers, brass founders and finishers, metal polishers and workers, boiler makers, constructive engineers, and manufacturers of electrical appliances and parts. The subscribers (with one share each) are:—N. F. Nalder, Fairlight, Southend-on-Sea, electrical engineer; J. J. M. Hilton, Morland Road, Croydon, electrical engineer; F. R. Boardman, 238, Tottenham Court Road, W., secretary; W. H. Gretton, 108, Gaskarth Road, Balham Hill, S.W., engineer; A. G. Evans, 64, Antill Road, South Tottenham, draughtsman; W. Whitington, 5, North Street, Westminster, electrician; C. Covington, 103, Gore Road, Victoria Park, E., electrician. The number of directors is not to be less than two, nor more than five; the subscribers are to appoint the first. Qualification one share; remuneration not more than £150 each per annum. Registered office Trafalgar Works, Bow Common Lane, Bow, E.

Lancashire Watch Company, Limited (51,654).—Registered March 13th, with capital £200,000 in £10 shares, to acquire the business carried on by the Lancashire Watch Company, Limited (incorporated in 1888), to enter into a certain agreement, and to manufacture and deal in watches, clocks, watch and clock movements, watch and clock cases, timekeepers, chronometers, electric bells, batteries, and other electrical apparatus, gas lighters, &c. The subscribers (with one share each) are:—A. A. Menzies, 53, North John Street, Liverpool, chartered accountant: T. P. Hewitt, Eccleston Park, Prescot, watch maker; C. J. Hewitt, 5, High Street, Prescot, watch maker; J. Hewitt, 13, West Street, Prescot, watch maker; S. Farren, 19, Station Road, Prescot, watch maker; G. Dagnall, 21, Derby Street, Prescot, watch maker; J. Wood, 29, Station Road, Prescot, watch maker. The number of directors is not to be less than five nor more than eight; the first are W. D. Houghton, A. A. Menzies, T. Dennett, T. P. Hewitt, and T. R. Ronald; qualification, 1 share; remuneration as the company may decide. Registered by Rowcliffes, Rawle & Co., 1, Bedford Row, W.C.

C. & A. Musker, Limited (51,568).—Registered March 8th with capital £20,000 in £10 shares, to acquire the business carried on at Bootle, Lancashire, and elsewhere, as C. & A. Musker, to enter into a certain agreement, and to carry on the business of mechanical, hydraulic and electrical engineers, iron founders, tool makers, brass founders, metal workers, &c. The subscribers (with one share each) are:—C. Musker, Dundee Street, Bootle, engineer; A. Musker, Dundee Street, Bootle, engineer; M. Musker, 37, Merton Road, Bootle, contractor; J. Musker, 5, Merton Road, Bootle, overseer; Miss Musker, 5, Merton Road, Bootle; H. Musker, 5, Merton Road, Bootle, law student; Mrs. C. Musker, 12, Trinity Road, Bootle. The control of the business is to be vested in the manager; qualification £1,000. Registered by Rowcliffes, Rawle & Co., 1, Bedford Row, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Newcastle-upon-Tyne Electric Supply Company, Limited (27,997).—This company's annual return was filed on March 2nd, when 9,179 shares were taken up out of a capital of £100,000, in £5 shares. Of these 221 are considered as paid, and £5 per share has been called on 8,108, and £4 per share on 850, resulting in the receipt of £44,240. £300 has been paid in advance of calls.

Newcastle and District Electric Lighting Company, Limited (28,022).—This company's annual return was filed on March 2nd, when 9,918 shares were taken up out of a capital of £100,000 in £10 shares; £8 per share has been called on 5,000 and £3 per share on 4,918, and £54,754 has been paid; £565 has been received on advance of calls.

Cambridge Electric Supply Company, Limited (36,457).—This company filed its annual return on February 20th, when 4,925 shares were taken up out of a capital of £50,000, in £10 shares; £8 per share has been called, and £39,400 has been paid.

Esson Motor, Limited (49,536).—This company's statutory return was filed on February 4th, when 14 shares were taken up out of a capital of £20,000 in £200 shares; £120 per share has been called, and £1,440 has been paid, leaving £240 unpaid.

CITY NOTES.

The Hanley Corporation Accounts.

Although we have had the Hanley accounts in our hands for some days, we have not previously had an opportunity of commenting on them. It seems to us that Hanley provides an excellent example of the working of a moderate sized municipal station. The capital expenditure does not exceed £44,000, and the revenue, including that derived from street lighting, is not much more than £4,300, yet after paying all expenses and the various amounts to mortgage debt and sinking fund, there is a balance of £80 15s. 8d. carried to General District Rate Account. Not a great amount, perhaps, but sufficient to show that a moderate sized plant can, with careful management, soon reach the profit earning stage; moreover, it must not be forgotten in the case of Hanley that there is a good deal of street lighting, and this is being done at a most moderate cost, there being 30 arc lamps and 14 incandescents for street lighting, the total cost of which is £510. We give the cost of production below, and taking the small output into consideration, the managers have no reason to feel ashamed of the figures.

The following table gives the cost per unit:—

	1896.	1895.
Total capital expended	£44,143	£32,363
Number of units sold	247,881	—
Number of lamps connected	—	—
Revenue from sale of current	£4,362	—
Net revenue	£1,791	—
Average price obtained per unit	4·5d.	—

Cost of Production.	£	s.	d.	1896. Per unit.
Coal	755	0	0	·73d.
Oil, waste, water, and engine room stores	198	0	0	·19d.
Salaries and wages at generating station	586	0	0	·57d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	516	0	0	(Works' cost) 1·99d. ·50d.
Rent and taxes	156	0	0	·15d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	389	0	0	·38d.
Depreciation of buildings and plant account	—			—
Renewal fund account	—			—
Total	£2,600	0	0	2·52d.
Not included in above.				
Public lamps	174	0	0	
Total	£2,774	0	0	

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	4,362	0	0	4·5d.
Meter rents	106	0	0	—
Sale of lamps and other apparatus	92	0	0	—
Balance	6	0	0	—
Total	£4,566	0	0	4·5d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·52d.; works' cost, 1·99d.

The Oxford Electric Company, Limited.

The report of the directors, to be submitted to the shareholders at the sixth ordinary general meeting, to be held at the Randolph Hotel, Oxford, on Friday, March 19th, 1897, at 3.30 p.m., states that the revenue account shows a gross profit of £3,368 7s. 1d. After providing for the interest on the debenture issue there remains £1,818 3s., and adding £360 3s. brought forward from last year, the amount available for dividend is £2,178 6s. The directors recommend payment of a dividend at the rate of 4½ per cent. per annum upon the ordinary capital, the shares issued in March, 1896, ranking, in accordance with the terms of the prospectus, for one-half (2¼ per cent.). This dividend will absorb £1,640 18s. 6d., and £537 7s. 6d. will be left to carry forward to next year's accounts. Since the last report 4,055 8-C.P. lamps (or their equivalent) have been added to the system. On December 31st the number of lamps connected equalled 19,058 8-C.P. lamps. The directors see no reason why the increase of business during 1897 should not be equally satisfactory. In the conviction that the ultimate demand for electric current in Oxford will be much greater than was originally supposed, the directors have considered it advisable to still further increase the size of the generators. A considerable addition has been made to the plant during the year, and this, with an additional boiler, and transformer stations in suitable localities, will enable the company to instal an additional 15,000 8-C.P. lamps. The plant, where necessary, has been renewed, and the whole maintained in efficient order out of revenue. Notice has been given that the present debenture issue will be paid off during the year for the purpose of making an issue on terms more advantageous to the company. To provide for capital expenditure the directors propose to shortly issue 2,000 ordinary shares of £5 each, at a premium of 10s. per share, and to offer the shares, in the first instance, to the present shareholders. The directors who retire by rotation are Sir Henry C. Mance, C.I.E., and Mr. J. Irving Courtenay, M.A., who offer themselves for re-election. Mr. W. S. Carver, the auditor, offers himself for re-election.

Birmingham Electric Supply Company, Limited.

The annual meeting of this company was held on Thursday last week at Birmingham, Mr. H. Buckley presiding.

The report showed that the net profit, including a balance of £770 brought forward, was £9,652. The directors recommended the payment of a dividend of 4½ per cent., and to carry forward £1,042. The directors proposed, in order to meet the further necessary expenditure of the company, to offer the balance of the authorised share capital (£50,000) for subscription by the existing shareholders.

The Chairman, in moving the adoption of the report, remarked that the progress of the company during the last 12 months had been thoroughly satisfactory. It was true that the length of mains laid in 1896 was not equal to the amount laid in 1895, but during the year they had added considerably more to the buildings, plant and machinery. Everything indicated steady progress from the commencement, but the progress during the last 12 months was exceedingly satisfactory, and in round figures showed an increase of 50 per cent. over the previous year. The increase in the number of lamps was satisfactory, and the month of January last showed an improvement over the month of January, 1896, of 35 per cent.; and February, 1897, showed an increase of 55 per cent. over the corresponding month of the previous year. The expenditure on capital account had been heavy, and it had not come to an end, and for that reason the directors recommended the issue of the remaining portion of the registered capital. The unissued portion was £50,000, and the capital paid up £150,000. The terms upon which the capital should be issued had been carefully considered by the directors. He had heard that there was dissatisfaction upon the Stock Exchange that it was being issued at a premium. There was the temptation to issue it at a considerable premium, but, instead of asking for a premium of £2 or so, the directors had decided to ask the shareholders to issue the remaining capital at a premium of only 10s. It was proposed to give one share from the remaining capital for every three held. The report was adopted.

Mr. Rushbrooke (a shareholder) suggested that an interim dividend should be paid, but the Chairman pointed out that there would be some difficulty in doing that. The income in the first six months of the year was not similar to that in the last six months, and if the directors declared an interim dividend they could not say whether or not they had earned it.

A motion authorising the issue of the remaining capital was passed, and the retiring directors were re-elected.

The Richmond (Surrey) Electric Light and Power Company, Limited.

The directors' report and statement of accounts for 12 months to December 31st, 1896, states within that period a further sum of £1,780 has been expended on capital account, the necessary funds having been obtained by loan from the County of London and Brush Provincial Electric Lighting Company, Limited. The revenue account for 1896 shows a profit of £1,162 17s. 10d., as against £230 2s. 1d. in 1895. The balance of this amount, after payment of interest on debentures, mortgages, and temporary loans, has been appropriated as under:—

To Writing off balance of preliminary expenses	£138 17 11
„ Reduction of suspense account	210 17 3
„ Depreciation	200 0 0
Balance carried to balance sheet	33 14 9

The total number of lamps connected on December 31st last was equivalent to 7,125 of 8-C.P., being an increase for the year of 1,639. Since that date further applications for over 1,000 lamps have been received. The number of units sold within the year amounted to 97,044, being an increase of 16,588 over those sold in 1895, while at the same time the working expenses have been materially reduced. The mains were considerably extended during the year, and the Richmond Corporation having consented to nearly the whole of the borough being included in our area of supply (the Richmond order being one of those granted under the Electric Lighting Act of 1882), it is intended to make further extensions at an early date. Arrangements have also been made for doubling the storage battery capacity at the station. Mr. William Charles Braithwaite, having joined the Oxfordshire banking firm of Messrs. Gillett & Co., has resigned his seat at the board, and the directors have nominated Mr. F. E. Savory in his stead. Mr. Savory now retires by rotation, and, being eligible, offers himself for re-election. Mr. R. H. Marsh, the auditor, also retires, and offers himself for re-election.

Robey & Co., Limited.—The directors' report for the year 1896 states that after writing off £5,651 for depreciation, there remains a net profit of £32,289. After deducting debenture interest, and adding the amount brought forward from the previous year, there is a balance of £26,268 available for division. The directors recommend this sum to be appropriated as follows:—To the payment of a dividend of 10s. per share, amounting to £13,746, adding £12,000 to the reserve fund, and carrying forward £522.

Westminster Electric Supply Corporation, Limited.—Lord Suffield presided on Wednesday at an extraordinary general meeting, held at Eccleston Place, for the purpose of confirming as a special resolution, the resolution passed on the 24th ult., empowering the directors to redeem the founders' shares. On account of legal difficulties as to the proposed form, the meeting was adjourned.

The Direct Spanish Telegraph Company, Limited.—The directors have decided to recommend the payment of the dividend at the rate of 10 per cent. per annum on the preference shares, and a dividend, free of income-tax, at the rate of 4 per cent. per annum on the ordinary shares, both for the half-year ended December 31st, 1896.

The Charing Cross and Strand Electricity Supply Corporation, Limited.—The first batch of letters of allotment and regret in the issue of 10,000 4½ per cent. preference shares of £5 each at £6, have been posted. The issue has been very largely oversubscribed.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending March 14th, 1897, were £1,031; week ending March 15th, 1896, £949; increase, £82; total receipts for half-year, 1897, £11,806; corresponding period, 1896, £10,786; increase, £1,020.

The Liverpool Overhead Railway Company. The receipts for the week ending March 14th, 1897, amounted to £1,280; corresponding week last year, £1,095; increase, £185.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 12th, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,389.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME,	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, March 10th.	Closing Quotation, March 17th.	Business done during week ended March 17th, 1897. Highest.	Lowest.
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	100 —104	100 —104	101½	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	4 — 5	4 — 5	5	3⅜
1,612,880£	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	51 — 54	50 — 53	52	...
2,993,560£	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	95 — 96	95 — 96	96	95⅛
2,993,560£	Do. do. Defd.	Stock	...	...	...	8 — 8½	8 — 8½	...	...
138,600	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	15½— 15⅝	15½— 15⅝	15½	15 7/16
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	113 —117	113 —117	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	...	3½— 3⅝	3½— 3⅝	...	...
18,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	165 —170	165 —170	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8%	11 — 20	10½— 11½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10%	19 — 20	19 — 20	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	...	3½— 4½	3½— 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	...	105 —108 %	105 —108%	...	...
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½%	9 — 9½	9 — 9½	...	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	17 — 17⅝	17 — 17⅝	17⅝	17⅛
70,000	Do. 6 % Cum. Pref.	10	6 %	6	...	18 — 19	18 — 19	18⅝	18¼
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	103 —105	103 —105	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	127 —130	127 —130	129	128½
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	...	17½— 18	17⅝— 18½	18	17⅝
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	...	100 —104	100 —104	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	...	101 —104	101 —104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	127 —130	127 —130	...	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5%	100 —104	100 —104	101	...
107,600£	Do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	101 —104	101 —104	...	...
800,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4%	107 —110	107 —110	...	...
200,300£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4%	109 —112 %	109 —112 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	11 — 11½	11 — 11½	11 7/16	11 1/16
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	17 — 17½	17 — 17½	17 5/16	17⅛
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅓%	10 %	...	24 — 25	24 — 25	24⅞	...
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	102 —105	102 —105	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	53 — 56	54 — 57	55⅜	55½
100,000£	London Platino-Brasilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6%	107 —110	107 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2⅛	2 — 2⅛	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5½%	5½%	6⅞— 7⅛	7 — 7⅛	7 3/16	7 1/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	16¼	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	6¼	...
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	102 —105	103 —106	104	103
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	...	⅝— ¾	⅝— ¾	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4%	106 —109	107 —110	...	...
11,839	Reuter's Ltd.	8	nil	5 %	...	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	138 —143	138 —143	...	...
58,980	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3½— 3⅝	3½— 3⅝	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	100 —105	100 —105	...	...
15,509	West African Teleg., Ltd., 7,501 to 23,109	10	nil	4 %	...	5 — 6	5 — 6	...	...
238,380£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	101 —104	101 —104	...	...
30,000	West Coast of America Teleg., Ltd.	10	nil	nil	...	¾— 1½	¾— 1½	13/16	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	99 —105	100 —106	103	...
54,248	Western and Brazilian Teleg., Ltd.	15	3 %	3 %	...	8 — 8½	7⅝— 8½	...	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	6½— 7	6½— 6⅝	6⅝	6½
33,129	Do. do. do. Def. Ord.	7½	1 %	1 %	...	2 — 2½	1⅝— 2¼	2 3/16	2
165,280£	Do. do. do. 5 % Debs. "A," 1880 Red.	100	6 %	6 %	...	112 —116	112 —116	114½	112
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	...	109 —113	109 —113	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅛%	...	1 — 1½	1 — 1½	1 3/16	1 1/16
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	11¼ — 11⅝	11½— 11⅝	11⅝	11½
4,869	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	9½— 10½	9½— 10½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,600 ...	100	5 %	5 %	...	107 —110	107 —110	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7%	107 —112	107 —112	...	...
164,380£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6%	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	6 %	10½ — 11½	10½ — 11½	11⅜	10⅞
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	9½ — 10	9 — 9¼xd	9 7/16	9
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	4½%	4½%	112 —115	112 —115	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	18½ — 19½	19 — 20	19 15/16	19¼
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½ — 17½	16½ — 17½	16 15/16	...
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	132 —136	132 —136	134½	133
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	nil	nil	10⅜— 11⅛	11⅛— 11⅜	11½	11 1/16
20,000	Do. do. do. 6% Pref., 40,001—50,000 ...	10	...	6 %	6 %	14⅜— 15¼	14½— 15	14½	...
10,000	Do. do. do. iss. at 2 pm., all paid	10	...	...	...	14⅛— 14⅜	14⅛— 14⅜	14⅛	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	3 %	4 %	...	14½— 15½	15 — 16	15½	15
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	...	10½— 11	11 — 12	...	...
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	120 —124	120 —124	122	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2½%	4 %	12 — 13	12 — 13 xd	12⅝	12⅝
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	14 — 15	14 — 15	14 13/16	14⅜
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	...	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	104 —107	104 —107	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	5 %	7 %	9 %	12½— 13½	12½— 13½	13 5/16	13

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

‖ Dividends marked ‖ are for year consisting of the latter part of one year and the first part of the n

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share ‡	Dividends for the last three years. 1894.	1895.	1896	Closing Quotation, March 10th.	Closing Quotation March 17th.	Business done during week ended March 17th, 1897. Highest.	Lowest
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	S	2½%	...	...	⅝ — ⅞	¾ — 1	15/16	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	...	...	1½ — 1⅝	1½ — 1⅝	1 15/16	...
125,000£	Do. do. 4½ % Perp. Deb. Stock.	Stock	4½%	...	...	107 —111	106 —110	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	95 — 99	95 — 99	...	...
9,104	Central London Railway, Ord. Shares	10	...	...	...	9½ — 10	9½ — 10	9 15/16	9⅝
207,649	Do. do. do. £6 paid	10	...	...	...	5¼ — 5¾	5½ — 6	...	...
630,000£	City and South London Railway	Stock	1½%	1 3/16%	1 9/16%	59 — 61	59 — 61	59¾	59
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	1⅞ — 2¼	1⅞ — 2¼	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	5 %	5 %	...	1⅞ — 2¼	1⅞ — 2¼	2	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	...	3 — 4	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	4½%	4½%	...	105 —110	105 —110	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	5 %	...	1½ — 1⅝	1½ — 1⅝	1⅝	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2½ — 3	2½ — 3	3	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	⅞ — 1⅛	⅞ — 1⅛	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	...	...	⅜ — ½	⅜ — ½	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	10½%	...	11 — 12	11 — 12	...	
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	19½ — 20½	19 — 20	20⅛	19⅝
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½	18½ — 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	107 —112	107 —112xd	...	...
56,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	20½ — 21½	20½ — 21½	21½	20 15/16
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	106 —109	106 —109	108¼	107
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	2⅞%	2⅞%	12⅞ — 13	12⅞ — 12⅞	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	16½ — 17	16½ — 17	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	39 — 42	38 — 41xd	39¾	...
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	103 —106	103 —106	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000, £8 paid ...	10	...	...	...	10⅜ — 11¼	10⅜ — 11¼	11⅜	11⅛

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7½%; 1890—8%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9¼.
Electric Construction Corporation, 6 % Debentures, 103—106.
House-to-House Company (£5 paid), 5⅜—6¼.
Do. do. 7 % Preference, of £5, 8⅜—9¼ xd.
Do. do. 4½% Debentures of £100, 109—111.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 11—11½: 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½. Dividend, 1896, on Ordinary Shares 7 %.
London Electric Supply Corporation, £5 Ordinary, 1½—1¾.
Yorkshire House-to-House Electricity Company. £5 Ordinary Shares fully paid, 7—7½ xd. Dividend for 1896—7 %.

* From Birmingham Share List.

Bank rate of discount, 3 per cent. (February 4th, 1897).

REVIEW.

Submarine Cable Laying and Repairing. By H. D. Wilkinson, M.I.E.E. London: The *Electrician* Printing and Publishing Company, Limited, Salisbury Court, Fleet Street, E.C.

(*Concluded from page* 340.)

Turning now to Mr. Wilkinson's abundant, though somewhat interrupted matter concerning fault testing, we note first of all that the author has not appreciated the fact that Sullivan's galvanometer is extremely well adapted for this purpose. On page 235 occurs these words: "It is not absolutely necessary to have a dead-beat galvanometer for fault testing, and the marine galvanometer, in practised hands, behaves well enough; but it is a great convenience to have a dead beat one." Mr. Wilkinson will find that Sullivan's galvanometer meets all the above requirements, as a rule. On page 72 no mention is made of Mr. Rymer-Jones's modification of the fall of potential test for ship and shore use, as described at length in the Electrical Review of September 7th, 1894. This test was especially devised—and is especially valuable—for cases where the fault is known to have a very high and variable resistance, though it can be equally suitably applied to faults of low resistance faults. The latter, however, are less troublesome, and their localisation is already well provided for by several other ingenious tests. Mr. Rymer-Jones's method has been applied with uniform success on faults having resistances varying respectively from 5,000$^{\omega}$ to 30,000$^{\omega}$. In no case has the calculated distance been *more* than 2 to 3 nautical miles from the actual position of the fault, and in this instance the fault itself had a resistance of nearly 30,000$^{\omega}$, besides being extremely variable. Faults of lower resistance, however, have been localised by this method—even in quite long cables—within a fraction of a mile. It will be seen, therefore, that for a subsequent edition the description of the above method should be placed in this part of the book.

On page 73 the author says, "The question is often asked, 'How near can you ascertain the position of a fault in a cable?' Well, sometimes as near as to a tenth of a mile, and at other times not within 15 or 20 miles." We venture to think that localisation within 20 miles would not be very creditable to an electrician of the present day, even under the worst circumstances; neither would it suit the cable-owning company. Practical experience soon enables the tester after a cursory glance or a careful digest of his figures, to see whether his results can be relied upon, or whether they are, at the best, only a very rough approximation. If the latter, they must not be relied upon, and further tests should be made, especially where they can be performed from both ends of the line, communication being still possible.

In illustration of this view, let us consider Clark's "Fall of Potential Test." We will call one station A, and the other B. Both A and B charge the line from their respective ends in turn, and obtain independent values. All B's results are communicated to A, the controlling station, and if they do not bring the fault quite close to where it is shown to be by A's values, the tests are repeated. However, if, for some reason or another, check tests are impossible, A would always be able to see by the potential difference between his battery end, P, and cable end of coil, p, if the fault is varying considerably and consequently rendering the test valueless. This would also be indicated by any great variation in the amplitude of his discharges from the cable end p, compared with those obtained by B station when measuring the potential of the fault, p_1. If the fault has a very high and variable resistance (as shown by the discharges obtained), then a higher battery must be applied to open it out. The amount of this rests with the discretion of the observer and depends on circumstances; different maladies require different treatment. After the fault has thus been sufficiently broken down, the test must be repeated until the results warrant a definite opinion being formed. As Mr. Wilkinson remarks, several of the many tests, applicable to the same class of fault,

should be taken, if possible, as a check on one another, and our remarks here as regards repetition tests until a sufficient number of reliable results are obtained, equally apply to any other test methods which may be adopted. Every discretion should be used in discarding obviously valueless results.

A high resistance fault is not necessarily an extremely difficult one to localise, as appears to be suggested. It is only when it is also *variable* that the difficulty arises, and, unfortunately, this is usually the case when the fault resistance is high. Indeed, a fault having a fairly low but very irregular resistance, will often give as much trouble to localise as one of much higher resistance. In such cases the best plan is to take a great many discharges from both ends, and carefully select those which compare favourably with each other, through being taken at a time when the fault exhibited the least variation. Much must be left to the individual in all these tests, and no hard and fast rule can be laid down for absolute guidance.

With reference to Kennelly's break test on page 204, the author says: "Even with large exposures, if they are a long way off, the necessary range of current cannot be sent through them, partly because the testing current is limited by the rules, and partly on account of the intervening resistance of the cable. . . . . But if the break is 5,000 or more ohms distant, the test cannot be applied, owing to insufficient current reaching the break." In taking exception to these remarks, we think that most electricians having practical experience with this test will agree that the distance of the break from the testing station makes no material difference in the way of detracting from the value or efficiency of the test; though, of course, for other obvious reasons, the nearer the fault to the testing station—within certain limits—the better. It is merely a question of what battery power should be employed. By Ohm's law, $C = \frac{E}{R}$; therefore, the more resistance there is between the testing battery and the fault, the higher the voltage should be made. To take an example, assuming the resistance of the cable under test + the fault to be 6,000$^{\omega}$, then by applying Kennelly's test (reproduction method), and using a low-shunted dead-beat galvanometer, the battery power allowable under these conditions, so as to keep within the limits of Kennelly's law of fault resistance, would be:—

Taking the E.M.F. of the cells used to be 1·5 volts each:

100 cells = 150 volts, and $\frac{150 \times 1{,}000}{6{,}000} = 25$ milliamperes.

This is so, partly owing to the combined resistance of the galvanometer and shunt being negligible, and also that of the internal resistance of the cells used, since the cable readings and the reproductions through the coils are taken under precisely the same conditions. And now with special reference to the words (above quoted) "partly because the testing E.M.F. is limited by the rules, &c." Limited by what rules? certainly not by those governing Kennelly's test. Indeed, altogether the note concerning the general limitation of the testing current to 50 volts is beyond our comprehension. Possibly by this it is meant that certain cable companies will not allow their lines to be tested with a higher voltage, lest incipient faults should be developed in an already weak cable. Under such stringent conditions it must be admitted that Kennelly's test is seriously handicapped, if not rendered practically useless. Without the above stipulations this test is most invaluable, as the only really absolute one of its kind. If, however, the battery power is to be limited to 50 volts, as stated, then the results obtained would only be quite approximate, and not at all reliable. The specimens of Kennelly's test given on pages 211 and 212 are scarcely well chosen. They introduce a bad series of values, there being much too wide a difference between the first and second pairs—indeed, the first mean on page 212 should have been discarded altogether; moreover, the first test has been commenced by applying the lowest current to line—a plan not to be recommended. The better course is always to take the greater number of milliamperes (of each pair) to line first, then the corresponding couple; say, for example, 60—15 cells, 52—13, 48—12, and so on, instead of starting at the lowest current strength and working up to the maximum. By applying the higher battery power first, the fault is opened out to start with, and will remain more constant under the decreasing voltage than by the plan of gradually increasing the power used, which involves the opening out of the fault throughout the execution of the test.

No mention appears to be made in this book of the reproduction method of taking Kennelly's test. Under many conditions this possesses several advantages. In the first place, results are obtained much quicker than by the bridge method. This is all important where the fault is variable under the testing current. Secondly, only one galvanometer (dead beat) is required, and the electrician can give his undivided attention to the deflection obtained on the cable, or when reproducing the same through the resistance coils. With the bridge system, on the other hand, a second galvanometer is employed to observe the current passing the moment a balance is obtained on the first. This involves extra work and exactitude. It is true that by this method the current passing may be *calculated* instead of observed; but this usually proves a more lengthy operation, and often introduces error. When testing for the position of a fault, a second galvanometer is not always available. In adopting the reproduction method, however, it is a comparatively simple matter to note the constant of the galvanometer, and work out the limits of current strength—expressed in scale divisions — by Kennelly's law of fault resistance. Certainly on board ship it is extremely difficult, if not impossible, with the old pattern of marine galvanometer (Thomson's), owing to oscillations, &c., to read deflections with any accuracy, no matter how perfectly the suspension is balanced. But with the new instrument of Mr. Sullivan's, this objection to the reproduction method of taking Kennelly's test is overcome, even though the ship be rolling heavily at the time.

In the Appendix (page 395), concerning Kennelly's test, the author says: " . . . . this involves a rather tedious adjustment of resistance or battery power in order to obtain the required ratio between the two currents." To this we would say that no such tedious adjustment is necessary, so long as the cells are in good order; and under these circumstances it will not even be necessary to check their respective electromotive forces—if using the reproduction method when the number of cells are changed for each pair—and the relative deflections from the cable with the higher and lower battery power of each pair in the ratio of 4 to 1 (say, 40 and 10 cells, and so on) actually prove the respective strengths of current in operation. Provided the ratios are a near approximation, the results will be substantially correct. By the bridge method, however, the above remarks would not apply when the current is varied by adjustment of the bridge arms. As regards changing the battery power, that is a very simple matter. The carbon pole should be kept constant. The one change necessary during each pair may be conveniently made by employing a switch commutator for the purpose, readily adjustable for the pre-arranged changes of current.

The recent contribution to this journal emanating respectively from Mr. J. Rymer-Jones and Mr. Herbert Cann, tend to throw much extra light on this subject.

On page 191, the author credits Mr. Kennelly with the "improved Blavier." This, however, we believe to be due to Mr. H. Kingsford, who read a paper on the subject before the then Society of Telegraph Engineers in 1885, entitled, "A Method of Localising a Fault in a Cable by Tests from one end only." Here Mr. Kingsford pointed out that a pure and simple Blavier test must always give an erroneous result. Mr. Kingsford's modified formulæ were, on the one hand, applicable to the direct deflection method, and, on the other, to the bridge method. The formula for the latter was for cases in which the resistance is inserted in direct line with the cable. Shortly afterwards, in commenting on this paper, Mr. Kennelly pointed out in a letter to the *Electrician* (Vol. v., page 267), that the resistance should be inserted in the battery circuit, which is undoubtedly the case. A clearer account of Mr. Kennelly's method subsequently appeared in the columns of this Journal.

On pages 264 and 265, Mr. Wilkinson gives a description and illustration of Mr. Willoughby Smith's ship and shore test whilst laying. He also here describes and illustrates the modification of the above for purposes of fault localisation, due to Mr. Herbert Taylor, M.Inst.C.E.

Altogether, we think Mr. Wilkinson's work a distinctly useful accompaniment to the library of the practical cable

electrician, as well as to the cable engineer of the present day. We have ventured here to point out a few omissions and alterations which might suitably be made in what we think to be the proper order of the subject, which, indeed, should also receive attention and reform. We heartily congratulate the author on the result of his labours.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

On Some Repairs to the South American Company's Cable off Cape Verde in 1893 and 1895. By H. Benest, Assoc. M.Inst., C.E., Associate. (Read March 11th, 1897.)

In relating the experiences of these two cable repairs, the writer believes that some novel features present themselves—firstly, in the presumable existence of submarine streams, or outlets of springs, or other abnormal conditions, in a certain locality of the North Atlantic Ocean; and secondly, in the effects of such physical conditions upon telegraph cables.

That some such conditions exist appears to be pretty certain, by the evidence supplied at the points of rupture.

A brief *resumé* of the establishment of the submarine telegraph between the coasts of Africa and Brazil is here necessary before recounting the work of repairs.

This South American cable was made at Silvertown, and laid in 1892 by the India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited, their ss. *Silvertown* carrying and laying the whole cable.

The terminal points are at Saint Louis, in Senegal, on the West Coast of Africa, and at Pernambuco, on the coast of Brazil. A station is established on the island of Fernando Noronha, some 250 miles from Pernambuco, thus forming two sections.

The section between Pernambuco and Noronha has a conductor of 225 lbs. of copper, and a dielectric of 225 lbs. of India-rubber per nautical mile. A substantial jute bedding surrounds the core, and a sheath of 16 galvanised steel wires of 0·092 inch diameter is superposed; the breaking stress of the wire employed being 84 tons to the square inch. Each wire is coated with a tarry compound, and has a tarred cotton tape helically laid around it. The whole cable is served round with a helically laid cotton tape, and then with 20 hemp cords applied with a lay reserve to that of the tape. The finished diameter is slightly over 1 inch. This type is called light deep-sea, and its weight per knot wet in air is 43½ cwt., and in sea water 23 cwt. The specific gravity is 2·107.

The heavy deep-sea is sheathed with 12 galvanised iron wires, 0·160 inch diameter, of breaking stress of 30 tons per square inch; each wire is coated with a tarry compound, the sheathed cable being served with two spiral tapes of reverse lays, with a tarry compound between them, and a bituminous one outside. Its weight per knot wet in air is 60 cwt., in sea water 43 cwt.; specific gravity, 3·75; finished diameter, 0·975 inch.

The light intermediate type is sheathed with 12 No. 6 gauge 0·192 inch diameter galvanised iron wires; each wire is coated as in the deep-sea type, and the external covering consists of two tapes and compound. The finished diameter is 1·14 inches; its weight per knot wet in air is 86 cwt., in sea water 62 cwt.; specific gravity, 3·65.

The heavy intermediate type is sheathed with 12 galvanised iron wires 0·252 inch diameter, No. 3 gauge; each wire is coated as in the other types, the sheathed cable being served with two coverings of jute yarn and alternate coats of compound. Its weight per knot wet in air is 155 cwt., in sea water 107 cwt.; specific gravity, 3·2; finished diameter, 1·6 inches.

The shore end type is sheathed first with 12 galvanised iron wires, coated as before, each 0·160 diameter, then served with a covering of tanned jute yarn. The second and outer sheathing consists of 14 wires, galvanised and compounded, 0·300 inch diameter, two coverings of jute yarn and compound forming the outer protection. Its weight wet in air per knot is 288 cwt., in sea water 213 cwt.; specific gravity, 4·14; finished diameter, 2·01 inches.

This description also applies to the long section between Fernando Noronha and Senegal, except that the dielectric is of gutta-percha instead of India-rubber.

For telegraphic working, the two sections are joined up at the island, messages being sent direct between St. Louis and Pernambuco.

In the light deep-sea type of cable, which forms the major portion, pliability and buoyancy are combined. It is easy to coil, runs freely, has no tendency to kink, requires small retarding force in paying out, and in picking it up proves remarkably light to raise.

The length of the section between Pernambuco and Fernando Noronha is 357 nautical miles, and the distance over ground along line of cable 316·5 nautical miles. The distance in a direct course is 289 miles, and between the island and Cape San Roque, the nearest point on the Brazilian coast, 193 miles. The greatest depth encountered during the laying was 2,480 fathoms.

The island of Noronha lies N.E. and S.W. The extreme length, including outlying rocks and islets at the N.E. extremity, is about 7 miles; its greatest breadth is 1½ miles. Cape Placillière, to the S.W., is in latitude 3° 5′ S., longitude 32° 28′ W. This portion is very bold and exceedingly picturesque, consisting of bush-covered cliffs and rocky headlands, alternating with green hollows and sandy coves fringed with palms.

The length of the section between Fernando Noronha and St. Louis, Senegal, was originally 1,702·148 nautical miles, the distance over ground along line of cable being 1,548·218 miles. The total slack was originally 9·9 per cent.; the greatest average depth being 2,750 fathoms.

The coast of Africa in the latitude of Senegal does not lend itself to flowery description; a bare, sandy, hazy coast line, with a heavy surf continually breaking thereon, conveying to the mind an idea of desolate discomfort. Add to this a fierce heat during the day from an unclouded sun, tempered certainly by a cool N.E. wind during the fine season, or winter—from November to April—the other portion of the year being calm and rainy, with frequent tornadoes, and all is said that can be for this uninviting portion of the world.

The paying out of the long section was accomplished under most favourable conditions of weather. During eight days the depth passed over was from 2,300 to 2,800 fathoms. In nine days a length of 1,657 knots, including the shore end of Fernando, was laid; this being equal to 184 knots each day of 24 hours, or at the rate of 7·6 knots per hour.

These particulars are here set forth in order to show that the cable was well and truly laid. The agency by which it was broken, three months from the date of its completion in September, 1892, must therefore have been remarkable, especially at such a presumably safe depth as it occurred—between 1,200 and 1,300 fathoms.

News was received from St. Louis, in Senegal, on December 26th, 1892, that the St. Louis-Fernando Noronha section had broken down on that day; rough electrical observations at St. Louis indicating the break at about 130 miles distant by cable from the landing.

It appeared that on December 20th both St. Louis and Fernando were receiving messages with some difficulty for the first time since the completion of the line, and that the speed of working had to be reduced by about one-third. On December 24th a very heavy surf was breaking on the beach at St. Louis, the precursor of a violent storm which raged until the morning of the 26th. Some idea of the severity of the gale can be formed from the fact that the seas washed through the roadway in front of the cable house at St. Louis, and flooded a large portion of the native town of Guet n dar.

The signals between St. Louis and Fernando had continued to be of the same unsatisfactory character from the 20th until the closing of the office on the night of the 25th, when the storm was at its height. On the morning of the 26th the cable was found to be broken.

The cable steamer *Dacia* was fitted out with all despatch, and left the Thames with cable and all appliances for repairs on January 7th, 1893, arriving off St. Louis on January 21st, having provisioned at Santa Cruz de Tenerife on the way south.

Tests at St. Louis showed the position of the fault to be about 118 knots distant.

While the chief electrician, Mr. E. March Webb, was testing from shore, the ship proceeded to carry out a series of profile soundings during three days, when the *Dacia* put into the port of Dakar to take on board Mr. Webb and two representatives of the South American Company, and at once resumed sounding work. Some 50 casts with the wire were taken before and during grappling operations up to recovery of first end; a regular and easy descent from shoal to deep water, with soft green and grey mud bottom of varying consistency, being found, as details given further on will show.

The mean distance overground along the line of cable from St. Louis to the fault was estimated at 100 nautical miles. A mark buoy was placed at 87 miles, with a view to grapple the cable at a point to which the line would eventually be diverted in avoiding the dangerous ground.

Unfavourable weather interfered with work until the 29th January. On the 30th, at early dawn, the mark buoy was sighted, with flagstaff broken, and lamps gone. These were replaced, and in the afternoon, the sea having subsided, the grapnel was lowered in a depth of 850 fathoms. Grappling rope and chain were paid out to a length of 1,200 fathoms, and a drag was made to the S.E., the strain shown on dynamometer being from 2 to 3 tons. That evening the cable was hooked, the strain during picking up being from 3 to 4½ tons. At nine o'clock the cable was at the bows, the highest strain being 6 tons, falling to 4, and 3½ tons on slack cable coming over the ground.

After cutting the cable, and speaking St. Louis, the cable was tested, and found to be perfect electrically. Tests for conductor resistance and capacity were taken from both ship and shore, to determine length of piece in circuit, which was found to be 87·888 N.M. The mean depth on this length is 565 fathoms, and the mean bottom temperature, from soundings, is 47° Fahr., calculated temperature 46·75° Fahr.

The temperature and depths are set forth in detail on Sheet A; these being a transcript of Table A from Mr. Webb's electrical report, as printed in the company's log of the expedition.

Picking up the cable towards the break was now proceeded with until the following day. The mean strain while picking up was 2·6 tons, falling to 2·1 tons when at rest, the cable coming in in good condition, quite freely, and coiling well. On approaching the end, at a distance of 2 miles the strain rose to 6 tons; and, after some manœuvring, the cable evidently cleared itself from the bottom, and the end soon afterwards came on board from a depth of 1,220 fathoms. The cable showed evidence of much rubbing, the outer cords being stripped in places, unwound, and rucked up. The tape covering for about 140 fathoms from the end was rubbed bare to the sheathing wires *on one side only*. At the broken part about half an inch of the conductor was exposed, both copper and gutta being nearly covered by the sheathing wires; the appearance indicated a

tension break, with some slight torsion. The sheathing wires were well drawn down at their ends, showing a fair break at full breaking strain; in fact, from its appearance it might have been broken in a testing machine.

Additional soundings were taken in a profile line from this position towards the E.S.E., and across the line of cable, see chart, and details further on.

A marked difference was observed in the character of the bottom on this line of soundings—a very soft green mud, and ooze, in place of the stiff green mud hitherto found.

While the sounding was going on, the recently picked up cable, after eliminating the damaged portion near the end, was joined up with the new cable ready for re-laying; 23·75 N.M. being thus utilised.

On February 2nd the last line of soundings was completed. A buoy was prepared for a mark, but could not be placed in position for grappling the Fernando side of the broken cable, because of weather unfavourable for observations to determine the ship's position, through a dense haze which prevailed all day, caused by fine particles of yellow dust blown from the desert land by strong north-easterly winds. Later in the day sights were obtained, and a mark buoy put down in latitude 14° 56′ N. and longitude 18° 3′ W., the depth being 1,200 fathoms. The grapnel was soon afterwards lowered in 1,300 fathoms, 1,650 fathoms of rope and chain being paid out. A drag was made to the S.E., with the strain steady at 3½ tons. Considerable swell existing, the grapnel rope soon began to suffer by hammering against the bow of the vessel, and by being rolled along the plating by the "send" of the ship. After five hours' grappling, accompanied by severe rolling of the ship, wind and sea had risen to such an extent that operations had to be suspended for a time.

On the afternoon of February 3rd, weather having moderated, fresh lights were placed upon the mark buoy, and the grapnel was lowered. A drag was again made to the S.E., the strain shown on the dynamometer being 4 tons. After grappling for five hours, at a rate of about 1 mile overground per hour, the strain rose to 5½ tons. The grappling line was now shortened. The strain while shortening in was 6 tons. No appreciable progress overground was made during half an hour after this, and the strain still rising, it was believed that cable was hooked. The operation of picking up was now commenced, a 5-ton strain being indicated, increasing to 6 tons, and to 7 tons when the bight of the cable appeared at the surface. Estimating from the approximate angle between the legs of the cable bight when above sea surface, the strain on the cable was about 5 tons. The indicated strain fell to 6 tons when at rest, and afterwards to 5 tons as the slack cable was drawn along the ground, thus proving that a sufficient quantity of slack had been laid originally.

Four hours were occupied in picking up, and at 3 a.m. the cable was secured by chains and drum ropes, and cut at the bight. The Fernando end was taken on board, and electrical tests showed that portion of the cable to be electrically perfect.

This Fernando end was now buoyed, and picking up the loose piece towards break was proceeded with, the strain keeping pretty steady at 4 tons, varying slightly to 3½ tons. On approaching the position of the break a sounding gave 1,160 fathoms, soft mud; the strain soon after this increasing to 5½ tons, and frequent stoppages were now necessary to allow cable to break away from the bottom. The strain suddenly falling to 2 tons, indicated that it had cleared some obstruction on the bottom. The cable now recovered was "screwy," and soon showed evidence of much rubbing, like its counterpart on the St. Louis portion.

On the evening of February 4th the end came on board. The break was similar to, and coincident with, the other end, the sheathing wires being close around the core, the conductor scarcely showing. The gutta-percha appeared as though it had been nipped by some hard pressure. Nearly 21 miles was recovered on this piece, which, after eliminating the damaged part, was joined up, spliced to the St. Louis portion of picked up cable, and coiled down ready to relay.

The depth at this position was 1,220 fathoms, soft mud and ooze.

The buoy on the end of the St. Louis portion was now "made for," to verify its safety before raising the Fernando end and joining up cable on board thereto, preparatory to paying out and completing repair. Contrary wind and current prevented the ship sighting the buoy that night, and it was at daylight on February 6th before it was seen.

Two freshly trimmed dioptric lights were put on the buoy, and the return to the Fernando end was at once made. Upon reaching this end at the close of the day the weather looked so promising that it was decided to at once pick up the cable and splice on. The strain while picking up was 2·9 tons, and when stopped 2·1 tons. A length equal to 1¼ knots of the cable that had been hanging from the grapnel when raising the bight was taken in, and not a sign of a kink found.

At eight o'clock, the splice being finished, the bight of the cable was slipped from forward aft, to bring cable on to the after (paying out) gear. The ship's engines were put slowly ahead at first, on account of cable being high in the tank, and there being but slight cohesion between the turns of the coil.

The first course was N. 28° W. true. The speed was increased to 4 knots per hour, and later on to 5 knots, at which rate the ship was kept during the night. The distance run upon the first course was 14½ miles. The second course was N. 19° E. true; distance run, 12½ miles. The third course was N. 73° E. true, and distance run 25 miles; all by log.

During the run on this course, the ship was stopped in order to coil down in the tank a laid out splice. When all was clear, the ship's engines were put on to 40·44 and 48 revolutions, representing from 5 to 6 knots speed per hour; the course being changed to N. 62° E. true.

The weather being overcast, morning observations could not be taken. Later on the sky cleared and a position was found, but so much haze obscured the horizon that the "fix" was afterwards proved to be incorrect. It placed the ship several miles astern of position by dead reckoning. The ship's engines had meanwhile been increased to 50 revolutions, equal to 6½ knots per hour. Shortly after eight o'clock the buoy on St. Louis end was sighted about 2 miles slightly on the starboard bow. At 10 o'clock the cable, St. Louis end, was on board, and, tests being satisfactory, the other, Fernando end, was passed from aft, and final splice started; a length equal to 0·25 N.M. on St. Louis end having been hove in to ensure freedom from kinks.

In the afternoon of February 7th, the splice being finished, the final bight was slipped, and the *Dacia* set on for Dakar, leaving the mark buoys in position until learning the result of the final electrical tests from St. Louis.

On testing towards Fernando, when the cable was taken on board for splicing on to the tank section, a dielectric resistance per N.M. of 13,756 megohms, at a calculated mean temperature of 34°, was found; the copper resistance being 4·885 ohms per N.M.; mean depth being taken as 2,142 fathoms, and mean bottom temperature of 35° Fahr. The distance by cable from this point to Fernando was 1,567·4 N.M.

A length of 47 N.M. of cable was recovered, and 73·6 N.M. used in repair, 39·6 N.M. of which was part of the 47 N.M. recovered. The length of the restored section, after repair, was increased by 26·5 N.M., the original length being = 1,702·15 N.M. The present = 1,728·67 N.M.; add to this the length of Fernando-Pernambuco section, = 357, gives entire length 2,085·67 N.M.

A slight alteration in mean depth and bottom temperature occurred in the working out of results, viz.:—

	Mean Depth.	Mean Bottom Temp.
Original section ...	2,172 fms.	34·9 F.
After repairs ...	2,142 „	35·2 F.

Charts showing direction in which the cable was picked up and relaid are appended. It will be observed that the cable was diverted from the original line along other courses for a distance overground = 57 N.M., and 17 miles to the westward of the position where the rupture occurred. The total slack given was = 16·3 N.M., = 28½ per cent. on the length paid out. Throughout this repair most valuable assistance was rendered, apart from the skilful navigation of the ship by Captain A. S. Thomson and his officers.

These repairs being completed, the vessel returned to London; but, unfortunately, further experience in this locality was to come.

Two years later, in March, 1895, a second interruption to the South American cable occurred, when the *Dacia* was engaged on some repairs to the Cadiz-Tenerife section of the Spanish National Telegraph Company's system, and experiencing very rough weather off Cape Trafalgar in attempting the passage of the Straits of Gibraltar to escape from a south-westerly gale of cyclonic violence.

To convey an idea of the startling suddenness with which this storm almost overwhelmed the ship, it is worth recording that at 8 a.m. a mark buoy and its moorings had just been picked up. The wind was S.W., afterwards veering to W.S.W. and W., fresh, squally, and cloudy. At 10 a.m. it blew a strong gale, with a heavy sea; at noon, a heavy gale; half an hour after noon, a fierce hurricane, with a tremendous sea: the ship rolled to such an extent that a big cutter in the davits was carried away by the boat filling, and she was smashed to bits against the side. The decks were deluged by huge seas, and some cattle were washed overboard. The steam launch started adrift through the ship labouring. Vivid lightning, with terrific peals of thunder, accompanied the storm, which had to be faced, as it would have been impossible to have made the passage of the Straits, or to enter the harbour at Cadiz. Everyone worked with desperate energy. Officers and staff toiled for hours getting tarpaulins into the mizzen rigging to keep the ship's head to the sea, the after-sails being split and mizzen gaff disabled. Broken ribs, hurts, and bruises to the crew and cable hands occurred while endeavouring to re-secure the heavy steam launch and other gear.

During the evening several steamers drew near, and there was a narrow escape from a serious collision, as the steamers were almost unmanageable. Some of them must have collided during that night with fatal results, for several steamers proceeding from the Mediterranean were never heard of from that day. The unfortunate Spanish cruiser *Reina Regente* had taken the Moorish envoys back to Tangier the previous day, and was upon her return to Cadiz—a five hours' run—when she foundered with 423 souls. Some 2,000 people in Seville and Cadiz were put into mourning through that awful disaster. The *Dacia* weathered the storm with difficulty, and the next morning made her way through the Straits, running before the moderating gale to Gibraltar, where news of the interruption to the South American cable was received. Later on, at Cadiz, on completion of the repairs to the Spanish cable, orders, with detailed instructions, were received from London to proceed south and effect repair. The ship left Cadiz on April 10th, for a position in latitude 15° 1′ 9″ N. and longitude 18° 4′ 7″ W., about 20 nautical miles to the south-westward of the scene of the former operations, touching *en route* at Santa Cruz de Tenerife to coal and provision. On April 19th the ship was at the position indicated, a mark buoy being put down and grappling commenced.

In view of this second interruption occurring after an interval only of two years from the first repair, it was decided to make a long detour, and while carrying out this operation to utilise temporarily a cable laid along the African coast, between St. Louis and Cape Verde Point.

The first drag was made to the westward in depth of 1,250 to 1,300 fathoms, green mud. A heavy intermittent swell, with moderate breeze, and current setting to the northward. Strain indicated on dynamometer varying to as high as 6 tons. Grappling rope being severely knocked and rolled against the bow. Ship rolling heavily.

Conditions not being favourable for securing cable if it were hooked, the grapnel was hove up, and work suspended for the time being.

It was observed that the sea was of a dirty green colour—an unusual appearance in deep water. After dark it became highly phosphorescent, with a strong pungent odour—the more so the nearer to the sea surface; the crew of a ship's boat alongside being severely affected by it.

Grappling was resumed on the 20th, and continued until the morning of the 21st, without result.

The climatic conditions at this position (40 miles W.N.W. from Cape Verde), in depth of 1,200 fathoms to 1,300 fathoms, on the evening and during the night of the 20th, were worthy of remark. The sun set like a pale distorted moon, sea and sky being of an ashen grey, and the horizon shrouded in mist. A clammy atmosphere, striking chill and raw. A strong odour of phosphorous, suggestive of gases liberated by myriads of decaying organisms. The scene was most weird and uncanny—Dantesque, in fact. Grey, dark, and silent; not a spark of life in sun, sea, or sky. Darkness, necessitating the cheerful brightness of the electric light, was a welcome change. Throughout the night similar conditions prevailed. On the 21st the atmosphere cleared, the sea assumed a brighter tint of green, and the sun shone; but this change also brought a strong breeze, rendering grappling out of the question. Some few soundings were taken to discover the nature of bottom to the south-westward.

On the 22nd, after a brief lull, the breeze sprang up again, with the usual swell at times, indicative the hereabouts of a strong westerly set; the ship being within the influence of the northern equatorial current which sweeps along the north-west coast of Africa, past the Cape Verde Islands, turning to the westward about the latitude of Cape Verde. Part of this current is driven by the north-east trade winds into the Caribbean Sea, but most of it sweeps north-westward outside the West Indies towards the North American coast, as explained by Ferrel's law. This meeting, or diverging, point of the current may probably account for some of the unusual conditions of climate met with.

The next drag was successful in hooking the cable, which was at the ship's bows at an early hour on the 23rd; the northern, St. Louis end, being buoyed, and the Fernando end, after testing, being at once spliced up with the section of new cable in tank for paying out towards Cape Verde, off which place it was the intention to break into the coast line of cable from St. Louis to Cape Verde, and join Fernando thereto, thus restoring communication at the earliest possible moment.

This operation was of a delicate nature, inasmuch as the cable from Fernando had to be buoyed, the coast cable above referred to grappled up, cut, and the northern (St. Louis) portion of this cable joined on to Fernando end, which had to be raised, and the bight lowered after making the splice.

(*To be continued.*)

The Northern Society of Electrical Engineers.

Methods of Charging for Electricity Supply. By R. P. Wilson, member. Read Monday, March 8th, 1897.

(*Concluded from page* 366.)

At Norwich the principle is applied to every consumer on the circuit, so that every consumer is automatically given a discount in direct proportion to his value to the undertakers as a source of profit, irrespective of the actual gross revenue he represents. By this method all the meters are read in the usual way, and the amount registered is charged at so much per unit, but the meters register the whole or a fraction of the units actually consumed, according to the time when they are used, and if for any reason any consumer increases the peak of the load curve on any night because he is giving a dance or holding a prayer meeting, he pays for the privilege, because his meter registers at the full rate.

The disadvantage of the Norwich system lies in the method of its application. All the meters which are of the periodic type are controlled from a central clock in the supply station, which increases or decreases their period of inactivity, according to the time of day.

From some points of view periodic meters are not in themselves desirable, but the objection to the Norwich system lies in the fact that a third wire for controlling the meter has to be led into every consumer's premises, so that it would be a matter of considerable difficulty to introduce the system in any station except at the commencement of the undertaking, while the first mains are being laid. The expense of running a special main with a service to every consumer would appear to be prohibitive and impracticable in an established station.

During the time that the author was a central station engineer he devoted some considerable attention to this subject from a perfectly disinterested point of view, and subsequently came to the conclusion that the maximum demand system was the best, but owing to some of the criticisms raised by those to whom he advocated its use he designed the automatic time switch before you.

This instrument is a modification of Mr. Kapp's, and has some claims to being considered an improvement. The switching over arrangement is much simpler, more easily adjusted, and consequently much cheaper to make, besides which, it is so constructed that both the commencement and the duration of both rates of charging can be varied and locked by means of one screw.

The diagram (fig. 3) shows the construction of the switch itself, which makes one complete revolution in 24 hours. Let us assume that the rates to be charged are 6d. and 3d. The duration of the 6d. rate is regulated by the position of the shield or quadrant, S, in relation to the periphery of the disc, D, and its commencement by loosening the disc on its shaft, and turning the hands of the clock till they show the time the 6d. rate should begin; the disc is then turned on the shaft till the spring, C, falls off the point, A, on to the shield, which is in turn adjusted in the same way, so that the spring, C, falls

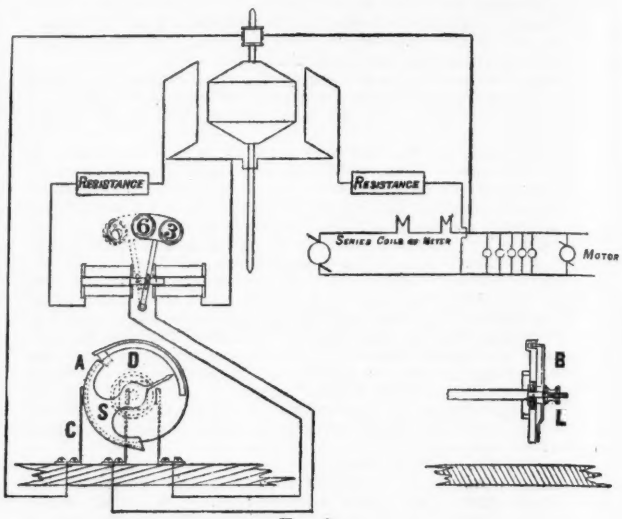


Fig. 3.

back again on to the disc at the time when the 3d. rate commences again. The apparatus is provided with an indicator, which serves to show the consumer the rate at which his consumption is being charged.

The only serious objection that has been so far raised to this apparatus is that the clocks might stop. This is, of course, possible; but the probability has been reduced to a minimum. The clock before

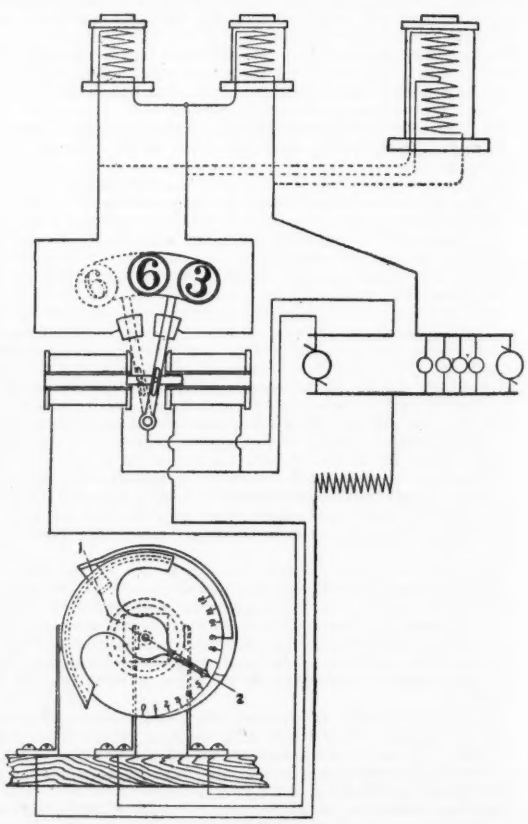


Fig. 4.

you is constructed to go for 42 days, is English made throughout, and is guaranteed by the makers not to gain or lose more than one minute a week for 15 years; it may, therefore, be safely assumed that the clock is not a difficulty, but there is no doubt, that however perfect the clock may be, some of them will stop; and it must be borne in mind that difficulties would arise in the adjustment of accounts if they did.

To minimise these difficulties, an automatic cut-out is provided, which causes the meter to register the full rate whenever the clock stops, and at the same time throws over the indicator to sixpence; thus the consumer has the opportunity of seeing, not only that the clock has stopped, but that he is being charged sixpence, so that in all probability he would consider this sufficient inducement to communicate with the undertakers.

Another difficulty, which is no more likely to happen than the stopping of the clock, is that a consumer might conceive the idea of trying to obtain an unfair reduction by overstating the time that the clock had stopped. To obviate any misunderstanding in this way, a set of dials is geared to the switch, showing how many days and hours the clock has gone; these dials are provided with a clutch, so that they may be set to zero when the meter-reading is taken.

In Mr. Kapp's original arrangement the alteration in the registration of the meter was effected by introducing a shunt across the terminals of the meter; but with very small resistances a shunt does not appear to be satisfactory, as a very small difference in the resistance of the switch contact would interfere with the accuracy of the meter-readings during, probably, 22 out of the 24 hours. It is not quite so simple, but far preferable to alter the ampere turns by putting the series winding of two meters in series during the 6d. rate, and cutting one out during the 3d. rate, or by arranging the winding on one meter so as to produce the desired result.

The diagram shows the connection arranged for a shunt meter, and it will be seen that during the period of light load two compounding coils are provided, so that the starting point of the meter may not be impaired by reducing the current in the armature.

In the case of ampere hour meters (Fig. 4) without any shunt circuit, the indicator, in addition to showing the rate being charged, alters the meter connections, and breaks its own exciting circuit at the end of its travel, so that no current is broken on the clock switch.

The other instrument illustrated in fig. 5 before you will, however, probably appeal to a large number of you. It consists of a maximum demand indicator, whose novelty and principal merit lies in its being

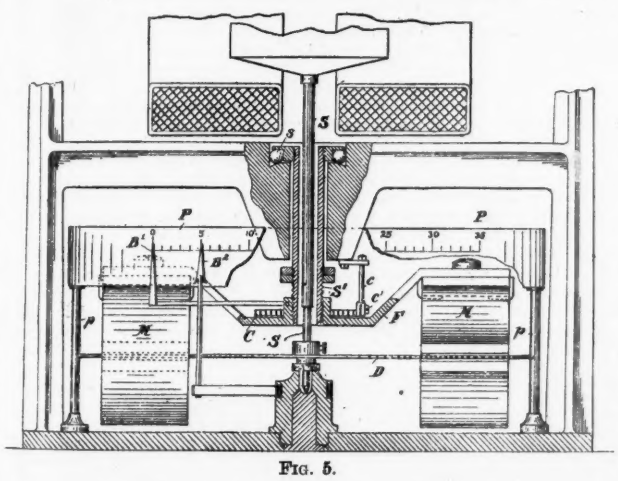


Fig. 5.

an integral part of an ordinary meter, so that instead of having two separate instruments to buy and keep in stock, you have only one, and, of course, only one to fix.

This instrument serves the purpose also of an indicating meter, and is provided with a pointer, from whose position the rate at which the meter is registering may be ascertained.

In addition to saving the loss in E.M.F., inseparable from Wright's indicator, a considerable saving is effected by only having one instrument to calibrate; there is also only one instrument to get out of order. The principle may, with more or less ease, be applied to any motor meter, and is really a torque indicator applied preferably to the existing retarding mechanism.

In the case of the Thomson meter, the magnets which provide the brake are suspended, and their motion is opposed by a flat spiral spring. The torque between the disc and the magnets is proportional to the energy passing through the meter, so that the ultimate position of the frame supporting the magnets constitutes a measure of the rate at which the meter is registering. A loose pointer, mounted coaxially with the magnet frame, serves to show the maximum speed the meter has attained, and consequently the maximum demand.

The sluggishness of the Wright indicator has been extolled as a virtue, but it is questionable whether it is so altogether. In the combined meter and indicator some care has been taken to avoid sluggishness, except to a very limited extent, although it can be made to work as slowly as may be desired.

The net result of the publicity already given to the subject dealt with in this paper appears to be that the only two systems that have attained any popularity are the maximum demand and the time switch.

Mr. Hordern, in his reply to the recent controversy in *Lightning*, appears to have some fear that the difficulties in solving this question are insuperable, but the author is sanguine that in the majority of cases it will be solved to the satisfaction of all parties concerned, and that at an early date.

In conclusion, the author trusts that the advertising strain in this paper will not militate against any utility that it may possibly possess but he has the satisfaction of knowing that no less a celebrity than Mr. Ferranti expressed an opinion, at an early meeting of this Society to the effect that advertisements of this nature were not necessarily objectionable.

The Société des Electriciens.

At the sitting of March 3rd, M. G. Sciama announced that at the elections which will take place next month, the Committee of Administration will present M. R. V. Picou for the season of 1898-99. M. Blanchon then held a discussion on the rapid charging of Tudor accumulators. He showed that these accumulators will admit of very high outputs without the available capacity falling below a certain normal limit. Thus an accumulator of 100 ampere hours capacity for a 10 hours discharge gives a capacity of 30 ampere hours in half an hour, 45 ampere hours in an hour, and 65 ampere hours in two hours. These accumulators are about to be used on the Puteaux tramway lines. The charging will be effected at a constant potential, and the elements will in 21 minutes gain 46 per cent. of their normal charge. M. Arnoux effected the charging of a Blot element in 5 minutes, at the rate of 30 amperes per kilogramme of electrodes at the commencement. M. Margaine also performed jointly with M. Picou some experiments in rapid charging on three Blot elements of 8·5 kilogrammes of electrodes. After 5 minutes charging, the element had received 22·8 ampere hours per kg. of electrodes, and an efficiency in energy of 60 per cent. After 15 minutes charging the available capacity amounted to 4 ampere hours per kg.

M. Dieudonne then read a long note from M. Francq on Mechanical Traction in Paris.

M. J. Laffargue, referring to M. Bonfante's paper, which had been read at the previous sitting, discussed briefly the wiring of dwelling houses. He examined several of the allegations made by M. Bonfante, and showed that if the precautions indicated as necessary with regard to the contiguity of gas and water pipes, were taken, electrical firms would be able to make good installations. He called attention to the defective construction of circuit-breakers. M. Bonfante replied in a few words and the sitting terminated.

SOME EXPERIMENTS WITH CATHODE RAYS.*

By A. A. C. SWINTON.

When the cathode rays in the focus form of Crookes tube are allowed to fall upon an anti-cathode surface made of ordinary electric light carbon, a brilliant and distinctly defined luminescence appears on the surface of the carbon at the point of impact of the rays. This luminescence appears to have very close relation to the fluorescence of glass and other fluorescent materials under similar influence. The effect is a purely surface effect, as when the cathode stream is rapidly deflected by means of a magnet, the luminescence on the carbon moves with no perceptible lag. Further, the luminescence on the carbon appears and disappears instantaneously with the cathode stream, and, again, the carbon surface undergoes fatigue when subjected to cathode rays for a long period, and recovers, to some extent, from this fatigue with rest, just as does glass.

The author has employed moveable anti-cathode screens of carbon for the purpose of investigating the form of the cathode ray discharge in the interior of focus tubes, with the following results.

When the screen is placed in the cone of cathode rays diverging from the focus, a sharply defined, bright ring, usually with a perfectly dark interior, is formed on the carbon of a diameter which becomes less and less as the vacuum is increased, or as the carbon surface is approached to the focus.

A similar result is obtained at low vacua, when the carbon screen is placed in the cathode rays between the concave cathode and the focus.

It thus appears that both the converging and diverging cones of cathode rays act as though they were not of uniform density throughout their section, but, at any rate in some instances, as if they were completely hollow.

This is, however, only true for short focus cathodes, as with long focus cathodes the cones do not act as though hollow, but produce uniformly luminescent discs upon the carbon.

Further experiments, using a carbon anti-cathode, and employing a movable metallic obstruction, which could be so placed in the focus-tube as to cut off a small portion of the cathode ray discharge either inside or outside the focus, show that the rays cross at the focus, and that there is no rotation or twisting of the rays. When the obstacle is placed in the divergent cone, a portion of the luminescent ring on the carbon is cut off exactly proportional to the angle subtended by the sides of the obstacle. On the other hand, when the obstacle is placed in the convergent cone, a much larger proportion of the ring is cut off, this being more marked with a high vacuum than with a low vacuum.

Experiments with a concave cathode from which a $\frac{1}{4}$th sector had been removed, confirm these results.

With a tube having a flat cathode, with the cathode rays brought to a focus by electro-magnetic means, hollow ring effects were produced on the carbon screen exactly similar to those obtained with a short focus concave cathode.

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* Abstract of paper read before the Royal Society on Thursday, March 11th, 1897.

Experiments with a tube fitted with a concave cathode of carbon seem to show that at high vacua the cathode discharge comes off entirely from the centre of the cathode, which becomes luminescent at the point where the cathode rays leave it.

With a tube fitted with two concave carbon cathodes, placed opposite to one another, and exhausted to a very high vacuum, particles of apparently incandescent carbon were found to pass continuously backwards and forwards between the two cathodes, forming a thin, but brilliant, golden-coloured stream joining the centres of the two cathodes at high vacua, and at lower vacua two cones of golden-coloured streamers. A spluttering at the centre showed where the particles travelling in opposite directions collided.

An experiment with two concave aluminium cathodes, arranged opposite one another, so that the two streams of cathode rays met in the centre of the tube, gave results from which it appears that X rays are not produced by opposite streams of cathode rays meeting one another, but only when cathode rays strike solid matter.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[Compiled expressly for this journal by W. P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.]*

5,383. "Improvements in primary galvanic batteries." S. F. Walker. Dated March 1st.

5,420. "Improvements in or relating to electric lamps suitable for carriages and for other purposes." A. H. J. Heard. Dated March 1st.

5,429. "Improvements in electric arc lamps specially suitable for projectors." W. M. Mordey. Dated March 1st.

5,430. "Improvements in speed regulating governors specially suitable for electric light and other high-speed engines." J. T. Marshall. Dated March 1st.

5,477. "Improvements in and relating to arc lamps." W. G. Heys. (The Puritan Electric Co., United States.) Dated March 2nd. (*Complete*).

5,479. "Improvements in and connected with dynamo-electric machines." C. H. Wade, J. Moores, and H. O. Farrell. Dated March 2nd.

5,493. "Improvements in plug contacts for electrical apparatus." Cambridge Scientific Instrument Co., Limited, and W. Pye. Dated March 2nd.

5,507. "Signalling electrically between ships, or between ships and the land, without wires." H. W. Sullivan. Dated March 2nd.

5,569. "Improved construction of asynchronous motor for single or polyphase alternating electrical currents in combination with an auxiliary synchronous motor." C. D. Abel. (La Société Anonyme pour la transmission de la force par l'électricité, France.) Dated March 2nd.

5,687. "Improvements in electric batteries." M. M. Bair. Dated March 3rd.

5,706. "Safety differential device for electric installations." H. H. Leigh. (E. Desroziers, France.) Dated March 3rd.

5,714. "Improved system of fitting up electric bells." H. W. Johnston. Dated March 4th.

5,723. "Electric light adjustable extension fitting." R. Hurry and M. G. Yooll. Dated March 4th.

5,771. "Improved apparatus for enabling persons to find any given number or name in a telephone register library catalogue or other index." H. W. Potter. Dated March 4th.

5,794. "Improvements in electrically operated clocks." R. Burk. Dated March 4th. (*Complete.*)

5,805. "Improvements in and in the manufacture of elements for secondary batteries." D. G. Fitz-Gerald. Dated March 4th.

5,819. "Improvements in apparatus for the demonstration of magnetic phenomena." H. Puls. Dated March 4th. (*Complete.*)

5,826. "Improvements in the active material of secondary batteries." A. Schanschieff. Dated March 5th.

5,859. "Improvements in electrical switches." C. M. Dorman and R. A. Smith. Dated March 5th. (*Complete.*)

5,885. "Improvements in or relating to the driving of vehicles by electro-motors." C. J. Hall and R. H. Fowler. Dated March 5th.

5,948. "Improvements in means and apparatus for discharging neutralising or removing electrical charges from paper and other fabrics during and after the process of manufacture." H. W. Rogers and W. M. Mordey. Dated March 8th.

5,957. "An improved method of increasing the surface insulation between connections on electrical switches and fuses." F. W. Heaton and H. Smith. Dated March 6th.

5,993. "Improvements in or connected with telephone transmitters." A. Boyston. (D. N. Rowar, United States, and C. H. Wilkinson, Canada.)

5,998. "Improvements in switchboards and controllers for electric circuits." L. Linder. Dated Mar 3 6th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d. (in stamps).]*

1896.

3,274. "Improved apparatus for the electro-deposition of metals." A. S. Smith, T. A. Smith, R. J. Smith, S. Smith and T. Deakin. Dated March 9th, 1896. Relates to improved apparatus for the deposition of metals, and consists of a hollow perforated barrel mounted upon a central sleeve adapted to revolve upon a specially arranged bar. In this barrel are placed the articles to receive the metallic deposit, the articles being brought into the effective electric circuit, so as to receive a deposit by contact (either directly or through one another, or through metallic contact arms) with the axis which forms the negative pole. 3 claims.

10,788. "Improvements in electric arc lamps." E. J. Bagnall. Dated May 19th, 1896. Relates to arc lamps, and more particularly to such as are adapted for use with alternating electric currents. The invention consists in providing a direct connection, without interposed yielding devices between the core of the solenoid and said clutch, so that the slightest variation in strength of the solenoid will be promptly and accurately transmitted to the carbons. A non-limited yielding connection between the core of the solenoid and retarder is provided so as to retard the separation of the carbons in forming the normal arc when the lamp is being started. 6 claims.

11,391. "Improvements in cut-outs for electrical uses." J. C. Reynolds. Dated May 26th, 1896. Relates to a cut-out for electrical purposes, comprising an open-ended hollowed casing of insulating material, provided with studs of insulating material in the hollow thereof for the attachment of the conductors. A cover of insulating material is adapted to press upon and clamp together the conductors at each of the studs, so as to make electrical contact between the terminal and fuse wire. Suitable means are provided for clamping the cover firmly to the casing. 7 claims.

13,295. "Improvements in or relating to electrically-controlled railway signals." W. P. Thompson. (F. McBrien, J. Wayland, J. H. Fleming.) Dated June 16th, 1896. Relates to electrically-controlled railway signals, the object of the invention being to provide a system which will effectually guard the movement of trains, and will permit the rails of the track to serve as the only conductors connecting the several sections. The line is divided into a number of sections and sub-sections, or "overlaps," the controlling electro-magnets actuating the signals are placed near the junctions. The signals are preferably operated on a normal danger principle, and are automatically thrown to safety when a train passes a signal station if the track ahead be clear, but will remain at danger if the track ahead be occupied, thus warning the engineer against entering the section; the signal is automatically restored to danger by the movement of the train. 9 claims.

14,463. "Improvements in telegraphic alphabets." S. Van Buren Essick. Dated June 30th, 1896. Relates to a telegraphic alphabet for transmission of impulses necessarily alternating in polarity, in which each letter is represented by a single impulse, and determined by a characteristic independent of the polarity of the impulse. 5 claims.

15,074. "Improvements in or relating to electrically ignited torches, cigar lighters, or the like." J. Hencken, J. H. Meyer. Dated July 7th, 1896. Relates to an improved cigar lighter actuated by means of an electric current through a sparking device. According to the invention, an inflammable torch is held within a suitable receptacle, and is ignited by the mere act of withdrawing it from the receptacle, but the electric igniting devices are not actuated by restoring the torch to its receptacle. 7 claims.

15,622. "Improvements in alternating current dynamo-electric machines." H. B. Little. Dated July 14th, 1896. Relates to improvements in alternating current dynamo-electric machines, and consists in making the cores detachable, thus rendering the armature coils capable of being easily and rapidly removed for alterations and substitution when required. 4 claims.

16,168. "Improvements in electric insulators." B. Du Bois Smock. Dated July 21st, 1896. Relates to an insulator consisting of a body portion having an opening to receive a wire and means for the attachment of an anchor wire. 9 claims.

16,726. "Improvements in electrodes for secondary batteries." F. W. Schneider. Dated July 28th, 1896. Relates to electrodes for secondary batteries. The electrodes are composed of tubes of variable cross section, intended to be partially filled with paste and placed horizontally, the upper lying parts of the tubes being perforated to admit of the entrance of the electrolyte to the paste without washing the latter out of the electrode. 4 claims.

17,124. "Improvements in and connected with conduits more especially suitable for electrical conductors." H. H. Lake. (E. T. Greenfield.) Dated August 4th, 1896. Relates to improvements in conduits for electrical conductors, and consists of a series of conduit tubes extending into a manhole chamber combined with flexible cross connecting tubes, and with detachable means for securing the flexible tubes to any pair of conduit tubes. 6 claims.

18,273. "Improvements in dynamo electric machines." H. H. Lake. (R. Lindell, E. H. Johnson.) Dated August 18th, 1896. The invention has reference to direct current dynamo-electric machine, and its object is to prevent shifting or distortion of the magnetic field in machines of this type when working under full load. The improvement consists in increasing the magnetic field, as the load increases, at the pole corners, where the commutation takes place, without corresponding magnetic increase at the opposite pole corners. 5 claims.